Monitoring of SDG 7 indicators in Latin American countries

Report prepared by Enerdata

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Contact

Laura Sudries, Bruno Lapillonne
laura.sudries@enerdata.net

Naciones Unidas CEPAL
ADEME Agence de la transition écologique
AFD Agence Française de Développement
Euroclima+
Funded by the European Union

EXECUTIVE SUMMARY

This report describes and compares trends in energy efficiency, renewables and energy access in 14 Latin American and Caribbean countries[1]. It aims at contributing to the monitoring of SDG 7 indicators but goes beyond the indicators usually considered for this monitoring, especially in the field of energy efficiency monitoring. The analysis is based on indicators prepared by sector (energy, transport, industrial, residential, services and agriculture) under the BIEE project ("Base de Información de Eficiencia Energética") of the Division of Natural Resources and Infrastructure of ECLAC.

The report was prepared by Bruno Lapillonne and Laura Sudries from Enerdata in close cooperation with ADEME, with the support of the French Development Agency (**AFD**), through the **EUROCLIMA** programme of the European commission, which aims to support countries in the Latin American and Caribbean region.

The main conclusions and findings are summarized below in the three areas of SDG 7.

Energy access

- In 12 out of the 14 countries reviewed over 93% of households had access to electricity in 2018. In Nicaragua and El Salvador, the two countries with the lowest level (89% in 2018), the rate of electrification is progressing rapidly (+9 and 7 points since 2010).

- Access to clean cooking technologies remains a challenge in Nicaragua (only 55% of households with such access) and, to a lesser extent, Paraguay (67%) and Peru (74%). These three countries are gradually catching up, with a high progression since 2010 (around +10-15 points).

Renewables

- The highest progression of renewables in the final consumption is observed in Uruguay (+8% points) due to the increasing use of biomass in industry, followed by Panama and Ecuador (+5 points). The share of renewables "heat" (mainly cooking) has decreased in most countries. In half of countries, it is not balanced by the penetration of renewable electricity.

Energy efficiency

- The primary energy intensity has decreased by around 2%/year in Costa Rica, Panama, Colombia, and El Salvador. Seven countries have increased the rate of "energy efficiency improvement" since 2010: Panama, Colombia, El Salvador, Costa Rica, Mexico, Ecuador and Bolivia, with for the four later a reversing of the increasing trend observed before. However, most LACs are not in line with SDG 7.3 goal stating to "double the rate of improvement in energy efficiency by 2030".

[1] Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Mexico, Nicaragua, Panama, Paraguay, Peru, and Uruguay.

- Trends in total or final energy intensities or in aggregate indicators by sector (consumption per household per vehicle) provide an economic assessment of energy consumption but do not tell anything about the factors behind this trend, in particular energy efficiency.

- To better understand what is going on and better measure the impacts of energy efficiency programmes more detailed indicators are required, such as the indicators developed in the framework of BIEE and illustrated in this report: Energy Efficiency Index, energy savings, decomposition of the variation of the consumption and financial indicators showing the monetary savings for the consumers linked to these energy savings.

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Project team

Didier Bosseboeuf from ADEME[2], Ruben Contreras Lisperguer, Rene Osvaldo Salgado Pavez y Diego Messina from the Division of Natural Resources and Infrastructure of ECLAC[3], Camille Le Thuc from AFD, Bruno Lapillonne, Laura Sudries, Estelle Payan, Guillaume Routin, Coline Bernard, Pierre Labarbe and Daniel Fellin from Enerdata

National partners

Jeferson B. Soares & Glaucio Vinicius Ramalho Faria from EPE, Empresa de Pesquisa Energética (Brazil), Tomas Elizondo and María Belén Goni from Ministerio de Economía (Argentina), Maria Pía Zanetti and Alejandra Reyes from Ministerio de Industria, Energía y Minería (Uruguay), Juan Ignacio Navarrete Barbosa and Flor de Mariá Chávez Sandoval from Comisión Nacional para el Uso Eficiente de la Energía (Mexico), Victor Bazan and Laura Lizano from Secretaria de Planificación del Subsector Energía (Costa Rica), Hernan Sepulveda and Monserrat Garcia Herrera from Ministerio de Energía (Chile), Oscar Galvez and Carlos Iglesias from Secretaría Nacional de Energía (Panamá)

[2] French Agency for Ecological Transition
[3] Economic Commission for Latin America and the Caribbean

1. INTRODUCTION

1.1. Objectives and content

The objective of this report is to describe and compare trends in energy efficiency, renewables and energy access in Latin American countries. The report is based on data and indicators prepared under the BIEE project (“Base de Información de Eficiencia Energética”). This project was initiated some ten years ago by the Division of Natural Resources and Infrastructure of ECLAC (known as CEPAL in Spanish), in close cooperation with ADEME, the French governmental agency on Energy Efficiency and Environment and Enerdata and led to the development of a set of energy efficiency indicators based on a common methodology.

In a new phase of the project prepared in the framework of UN-ECLAC's BIEE-ROSE[4] programme (Regional Observatory on Sustainable Energy), the project was extended to all indicators related to goal 7 of Sustainable Development Goals (SDG 7), as well as to the policy measures implemented in the region to support these goals. This new phase of the project is supported by the French Development Agency (**AFD**), through the **EUROCLIMA** programme of the European commission, which aims to support countries in the Latin American and Caribbean region. It benefits from the technical support of **ADEME** and **Enerdata**.

The BIEE-ROSE project relies on two data bases covering Latin America and Caribbean countries:

- The first one on SDG 7 **indicators** measures performances on energy efficiency, renewables and energy access, globally and by sector (energy, transport, industrial, residential, services and agriculture) (see https://biee-cepal.enerdata.net/datamapper/);

- The second database, the so-called BIEE policy data base, compiles national **policies** implemented by sector on energy efficiency, end-use renewables and energy access (see https://biee-cepal.enerdata.net/measures/).

Since the beginning, the BIEE project has gathered participants from 23 countries, in different phases, starting with 6 countries of South America (Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay). It was then extended to 8 Central American countries (Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama) and then to the remaining countries (Cuba, Ecuador, Colombia, Guyana, Peru and Venezuela) and to Caribbean countries (Barbados, Saint Lucia and Trinidad and Tobago).

The report presents data and indicators for the 14 countries for which data were completed and validated at the time of writing the report[5]: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Mexico, Nicaragua, Panama, Paraguay, Peru, and Uruguay.

The participants to BIEE are the following organizations, mainly Energy Ministries:
- Secretaría de Energía, Ministerio de Planificación Federal, Inversión Pública y Servicios, República Argentina;
- Division of Energy and Telecommunications, Office of the Prime Minister, Barbados;
- Empresa de Pesquisa Energética (EPE), Coordenação-Geral de Eficiência Energética, Departamento de Desenvolvimento Energético, Ministério de Minas e Energía, Estado Federativo de Brasil;

[4] BIEE: Base de Información de Eficiencia Energética; ROSE: Regional Observatory on Sustainable Energy.
https://www.cepal.org/es/proyectos/programa-biee-base-de-indicadores-de-eficiencia-energetica
https://www.cepal.org/es/rose
[5] July 2021; data for Dominican Republic and Guyana were still in process at the time of writing.

- Viceministerio de Desarrollo Energético, Ministerio de Hidrocarburos y Energía, Estado Plurinacional de Bolivia;
- Ministerio de Energía, República de Chile;
- Unidad de Planeamiento Minero - Energética, República de Colombia
- Secretaría de Planificación del Subsector Energía, República de Costa Rica
- Oficina Nacional para el Control Al Uso Racional de la Energía (ONURE), República de Cuba;
- Comisión Nacional de Energía, República Dominicana;
- Ministerio de Energía y Recursos Naturales No Renovables and **Instituto de Investigación Geológico y Energético (IIGE),** República del Ecuador;
- Consejo Nacional de Energía (CNE), República de El Salvador;
- Ministerio de Energía y Minas, República de Guatemala;
- Guyana Energy Agency, Guyana;
- Secretaria de Energía, República de Honduras;
- Comisión Nacional para el Uso Eficiente de la Energía (CONUEE), Estados Unidos Mexicanos;
- Ministerio de Energía y Minas, República de Nicaragua;
- Secretaría Nacional de Energía, República de Panamá;
- Viceministerio de Minas y Energía, Ministerio de Obras Públicas y Comunicaciones, República del Paraguay;
- Dirección General de Eficiencia Energética, Ministerio de Energía y Minas, República del Perú;
- Renewable Energy Division, Sustainable Development Department, Saint Lucia;
- Ministry of Energy Industries, Trinidad and Tobago
- Dirección Nacional de Energía (DNE), Ministerio de Industria, Energía y Minería (MIEM), República Oriental del Uruguay
- Ministerio del Poder Popular para la Energía Eléctrica, República Bolivariana de Venezuela

The main energy efficiency indicators are presented in an interactive database with maps and graphs on the BIEE web site at https://biee-cepal.enerdata.net/en/datamapper/.

1.2. Data sources

As countries had different previous experiences with the BIEE project and to alleviate the work for national teams, the data collection has been organized as follows.

- For countries that participated in the previous phases of the BIEE project and have continued to update the BIEE database: Argentina, Brazil, Mexico, Uruguay, Dominican Republic and Guyana, all data were directly collected by national teams in the BIEE data template. The data were collected from national institutions (Ministries, Statistical Institutes), power and gas utilities, oil companies, industry associations, banks, etc.

- For all the other countries, the aggregate data were collected from OLADE and CEPALSTAT by Enerdata and the more disaggregated data necessary for the calculation of advanced energy efficiency indicators were collected in a simplified template from national BIEE focal points and included in the full BIEE data template by Enerdata.

The BIEE data template is an Excel file gathering all data required for the calculation of indicators. It is organised in 7 main sheets corresponding each to a sector: macro (for general macro-economic and energy balance data), energy, industry, households, services, transport and agriculture. A methodological guideline explains the definition and usual source of the data used in the data template and presents the calculation of all BIEE indicators[6].

[6] See Documentation at: https://biee-cepal.enerdata.net

2. OVERALL TRENDS

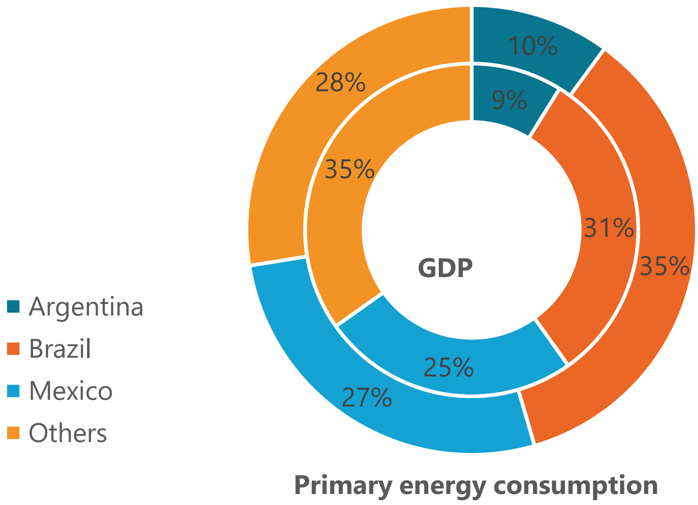
2.1. Introduction: trends in energy consumption

2.1.1. Primary energy consumption

Total energy consumption, also called primary energy consumption[7], includes final energy consumption and consumption and losses of the energy sector (also called transformation sector) as well as consumption for non-energy uses. The final energy consumption includes the consumption in industry (excluding energy sector), transportation, residential, services and agriculture.

The total energy consumption of Latin America[8] reached 818 Mtoe in 2018, with Brazil and Mexico representing 62**% of the total, followed by Argentina with 10%** (**Figure 1**)**. This consumption has been progressing by 0.5%/year on average, between 2010 and 2018, which is much slower than** GDP **growth, which averaged 1.7%/year**: in other words, there was a net decoupling between the primary energy consumption and the economic growth for the whole region.

Figure 1: Primary energy consumption and GDP in Latin America (2018)



Source: Enerdata based on IEA and OLADE for energy consumption and World Bank and IMF for GDP[9]

South America represents a major part of Latin America's GDP and primary consumption (64 and 67% respectively in 2018).

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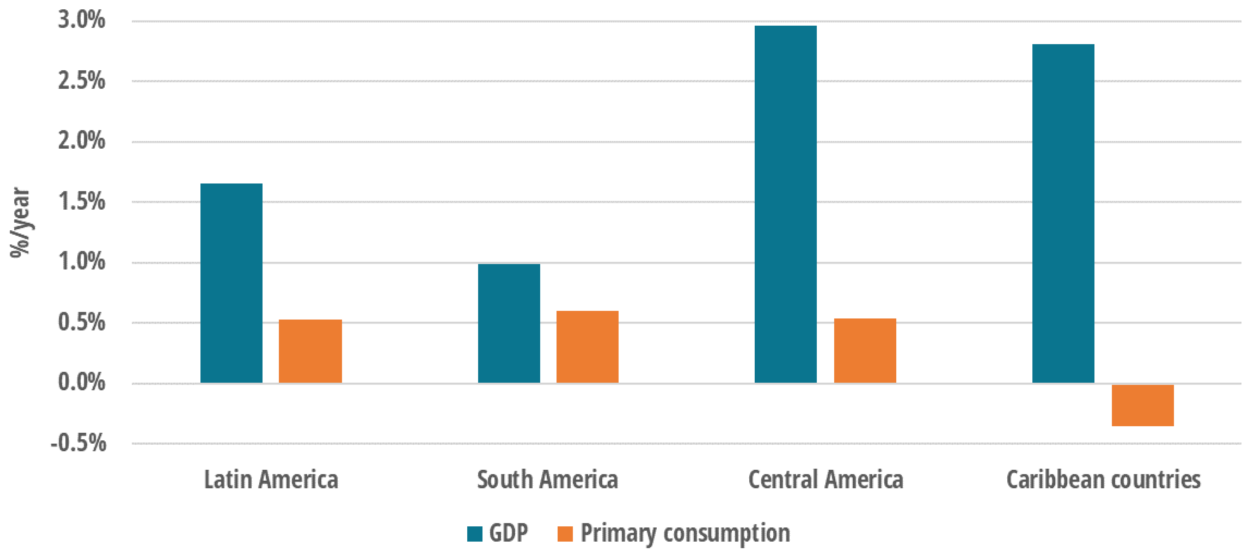
[7]It is called TPES, Total Primary Energy Supply, by IEA or "Oferta Totale" by OLADE.
[8]Latin America includes South America, Central America and Caribbean countries.
[9] GDP measured in purchasing power parities

Caribbean countries have the highest decoupling, since primary consumption declined by -0.4%/year, while GDP increased by 2.8%/year on average from 2010 to 2018. This decoupling was also important in Central America (0.5%/year for consumption and almost 3%/year for GDP).

Figure 2: Trends in primary consumption and GDP by sub-region (%/year, 2010-2018) [10]

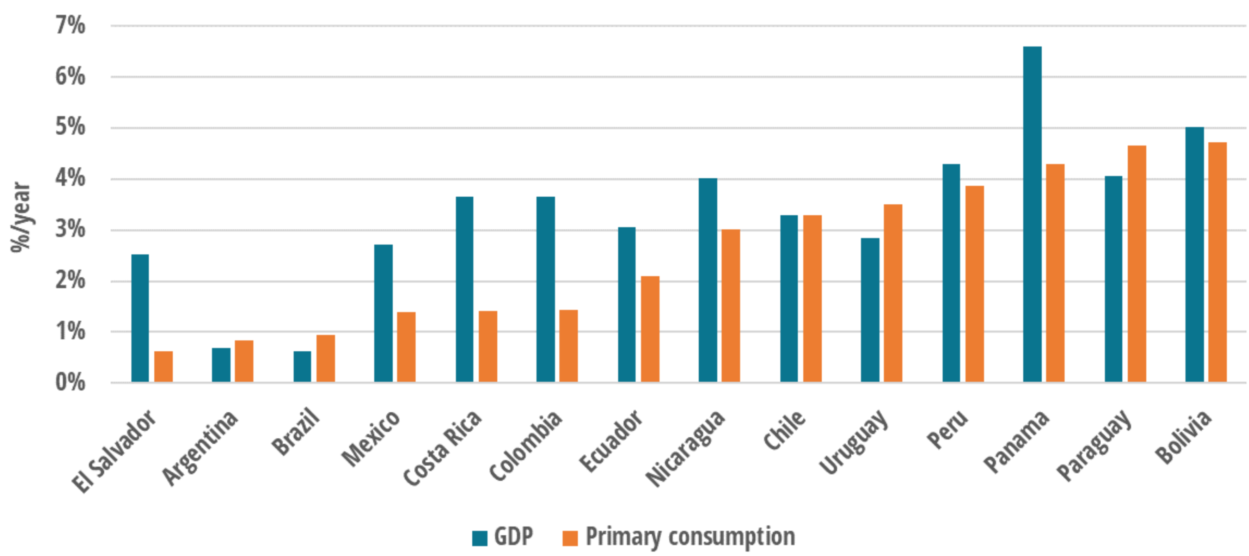


Source: Enerdata based on IEA and OLADE data for energy consumption and World Bank and IMF for GDP

In all BIEE countries, primary energy consumption increased between 2010 and 2018 but at different rates, from less than 1%/year in El Salvador, Argentina and Brazil to more than 4%/year in Panama, Paraguay and Bolivia.

In two thirds of BIEE countries[11], primary energy consumption increased slower than GDP from 2010 to 2018, in particular in El Salvador, Costa Rica, Colombia and Panama (Figure 3).

Figure 3: Trends in primary energy consumption and GDP by country (2010-2018)



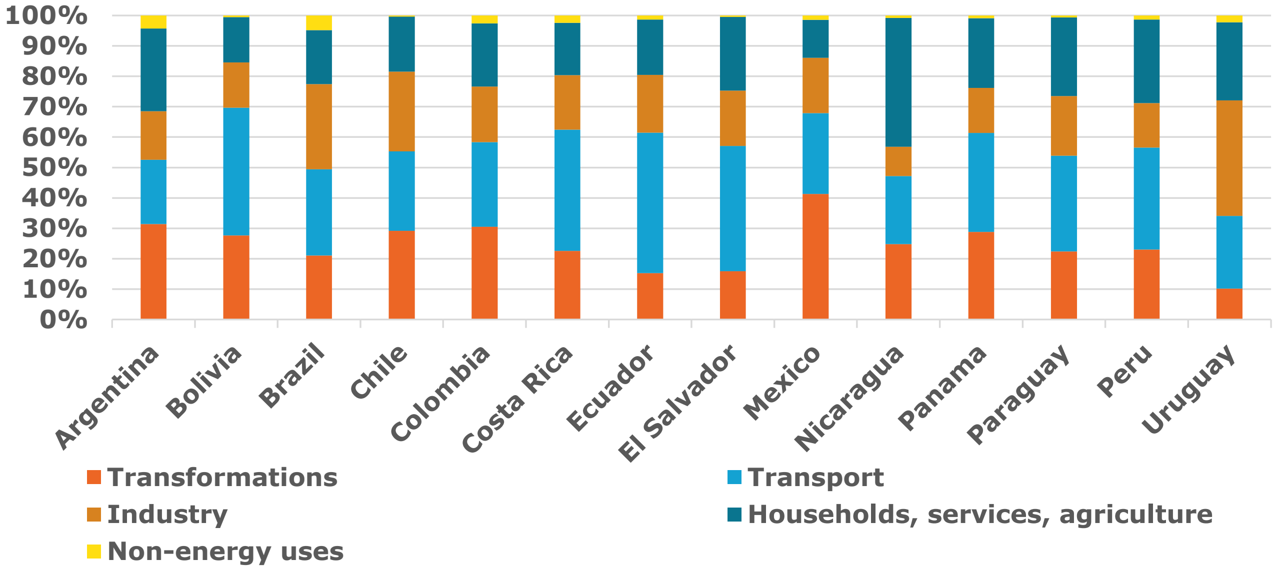
Source: BIEE Cepal

[10] **South America**: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela; **Central America:** Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama; **Caribbean**: Bahamas, Barbados, Bermuda, Cuba, Dominica, Dominican Rep., Grenada, Haiti, Jamaica, NL Antilles and Aruba, St Lucia, St Vincent and Grenadines, Trinidad and Tobago.

[11] BIEE countries refer to the 14 countries included in the analysis

Transformations (i.e. energy industries such as power or hydrocarbons sectors) absorb a high share of total energy consumption in Mexico (more than 40%), as well as in Argentina and Colombia (more than 30%), due to the importance of the oil and gas sector (and coal in Colombia). The share of transport is above 40% in Costa Rica, El Salvador, Bolivia and Ecuador. Industry has the highest share in Uruguay (38%), followed by Brazil (28%) and Chile (26%). Households, services and agriculture absorbs the largest share of total energy consumption in Nicaragua with 42%, followed by Peru and Argentina (around 30%).

Figure 4: Primary energy consumption by main sector (2018)

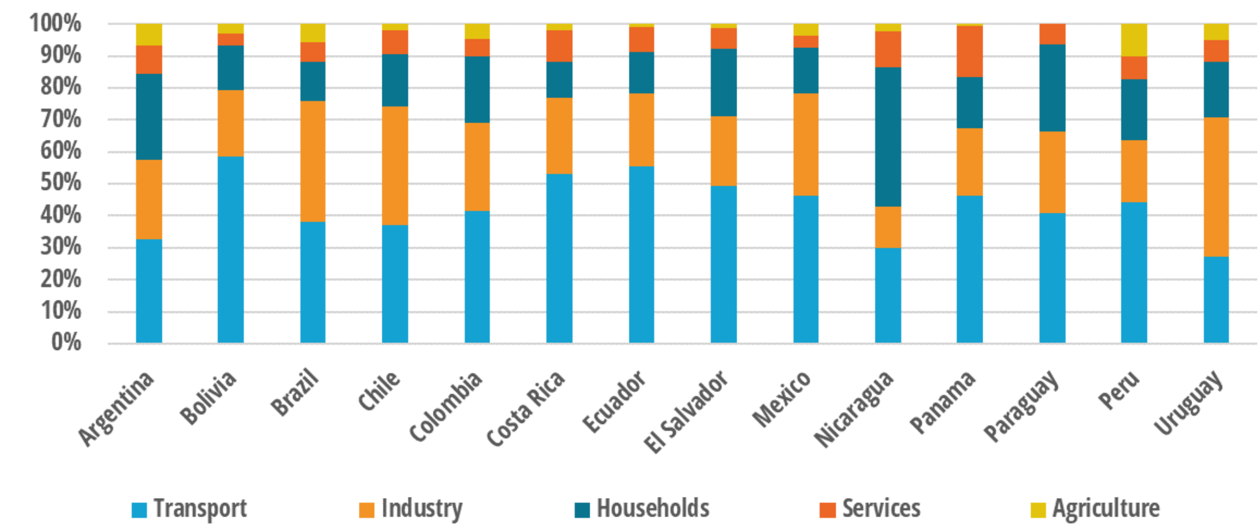


Source: BIEE Cepal

2.1.2. Final consumption

The final energy consumption of the 14 BIEE countries increased by 1.5 %/year between 2010 and 2018, reaching around 520 Mtoe. Transport accounted for more than half of the final consumption in Bolivia (58%), Ecuador (55%) and Costa Rica (53%). Industry has an important contribution in Uruguay (43%), Chile and Brazil (37%). Households absorb the largest part of this final consumption in Nicaragua (44%), because of a large use of biomass, followed by Argentina and Paraguay (both 27%) (because of space heating in Argentina and biomass in Nicaragua) (Figure 5).

Figure 5: Breakdown of final energy consumption by sector (2018)



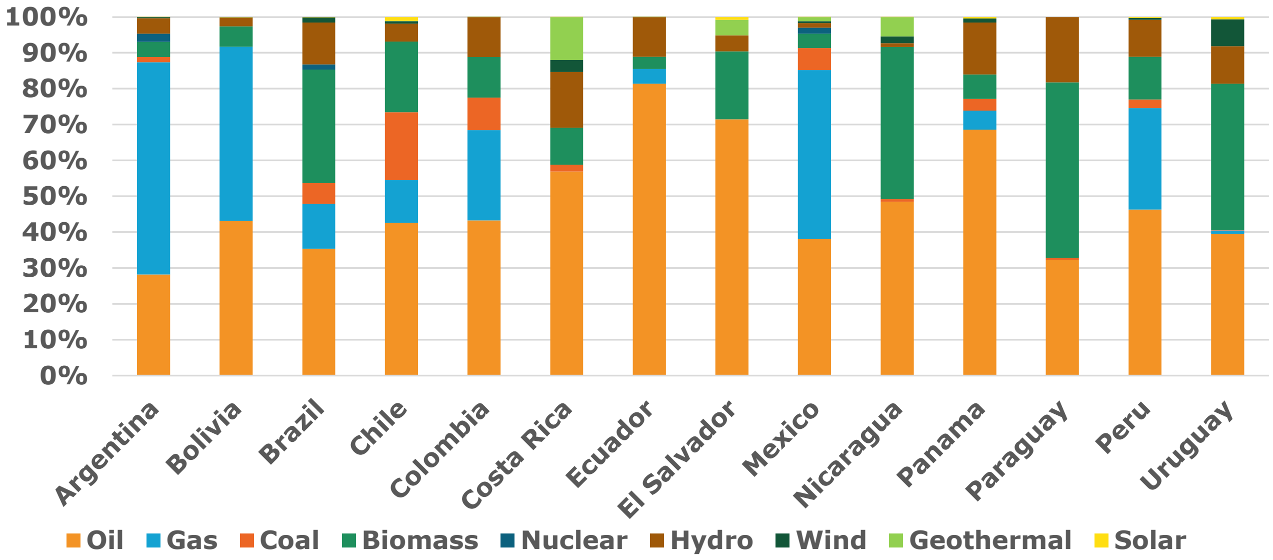
Source: BIEE Cepal

2.2. Overall trends for renewables

2.2.1. Share of renewables in primary consumption

In most of countries, oil dominates the primary energy consumption, from around 80% for Ecuador to 30% for Argentina and Paraguay. For Argentina, Bolivia and Mexico, the main energy source is gas, of which more than half is used in the energy sector (mainly for power generation). Paraguay and Uruguay rely mainly on biomass (49% and 41%, respectively). The use of coal is only significant in Chile where the thermal power production relies strongly on coal (Figure 6).

Figure 6: Breakdown of primary consumption by energy source (2018)



Source: BIEE Cepal

The share of renewables in primary energy consumption corresponds to the share of renewable electricity (hydro, wind, geothermal, solar) and biomass (wood, bagasse, wastes) in total primary energy consumption. The renewable electricity is normalized for hydro and wind (see Box 1).

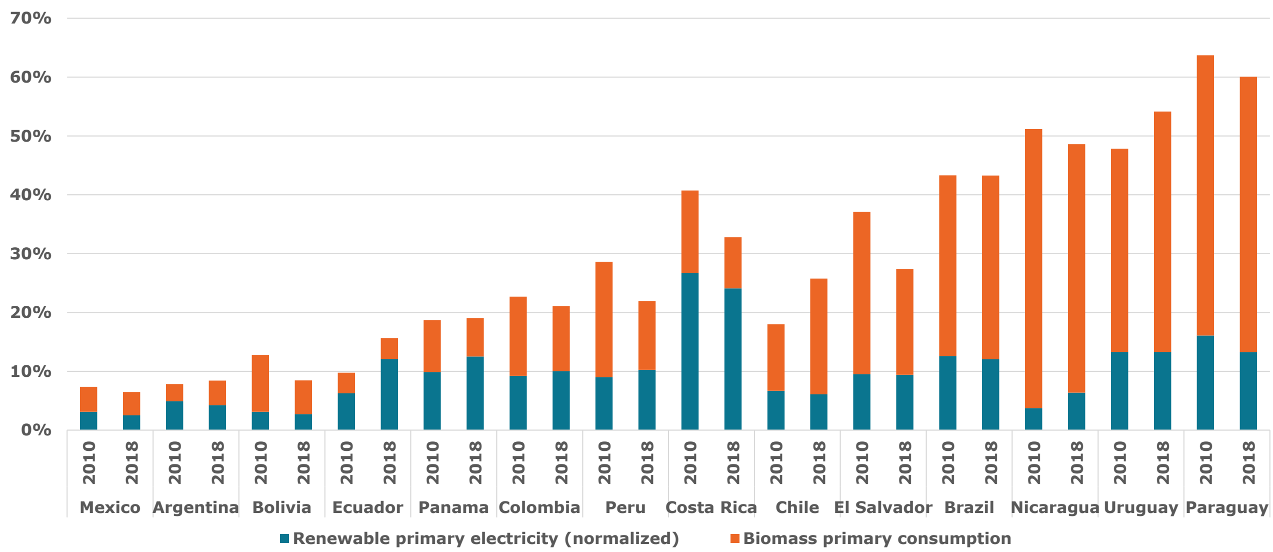
The substantial gaps between countries, from 6% in Mexico to 60% in Paraguay in 2018, are mostly linked to the importance of biomass, hydropower and, more recently the development of geothermal and wind power, which are unevenly split between countries. For instance, Paraguay has a large contribution of hydroelectricity, as well as Uruguay and Costa Rica. The residential and industrial sectors are the main consumers of biomass, except Brazil with a large use of biofuels in transport.

Between 2010 and 2018, different trends can be observed among countries:

- On the one hand, the share of biomass in primary consumption has significantly decreased in El Salvador (-10 points), Peru (-8 points), Nicaragua, Costa Rica (-5 points both) and Bolivia (-4 points), because of a lower use of traditional biomass in final consumption;
- On the other hand, the share of renewable electricity has increased in some countries due to the commissioning of new renewable power plants: the strongest progressions are observed in Ecuador (+6 points) and Panama (+3 points) with the development of hydropower in both countries.

For Chile, the share of biomass in primary consumption has increased (+8 points) due to the commissioning of new power plants using biomass and wastes. In the case of Uruguay, the increase (+6 points) is due to the industrial sector, with the commissioning of a large pulp and paper plant.

Figure 7: Trends in the share of renewables in primary consumption (2010-2018)

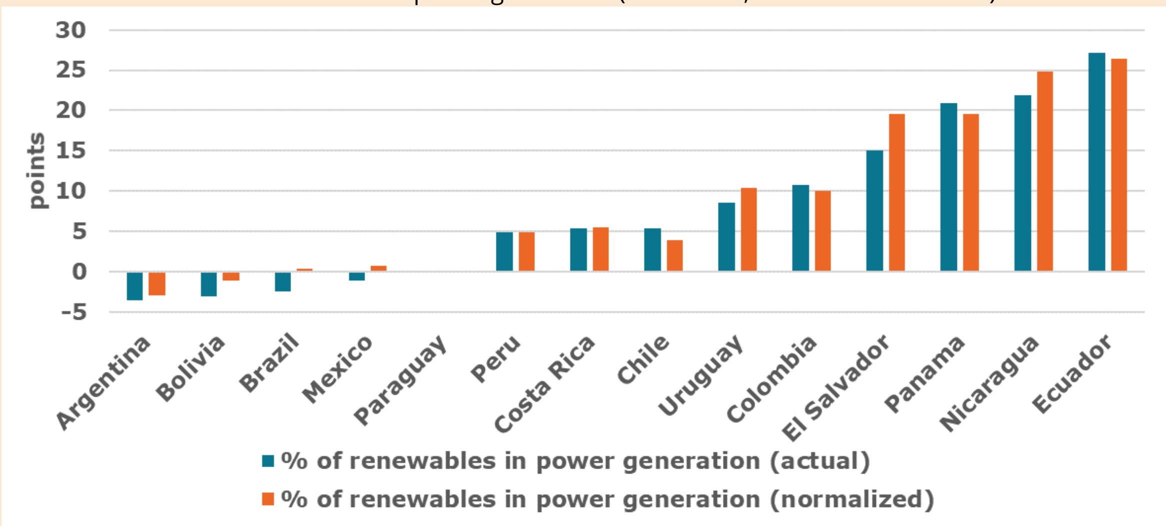


Source: BIEE Cepal

Box 1: Normalisation of renewable electricity[12]

For some countries the variation in the share of renewables in the power mix is quite different with the normalized value as shown below between 2010 and 2018 (e.g. much higher in El Salvador, Nicaragua and Uruguay), with even a reverse trend between normalized and actual values for Brazil and Mexico. The normalized value is more stable and the most relevant indicator to monitor the variation over a period.

Figure 8: Trends in share of renewables in power generation (2010-2018, actual VS normalized)



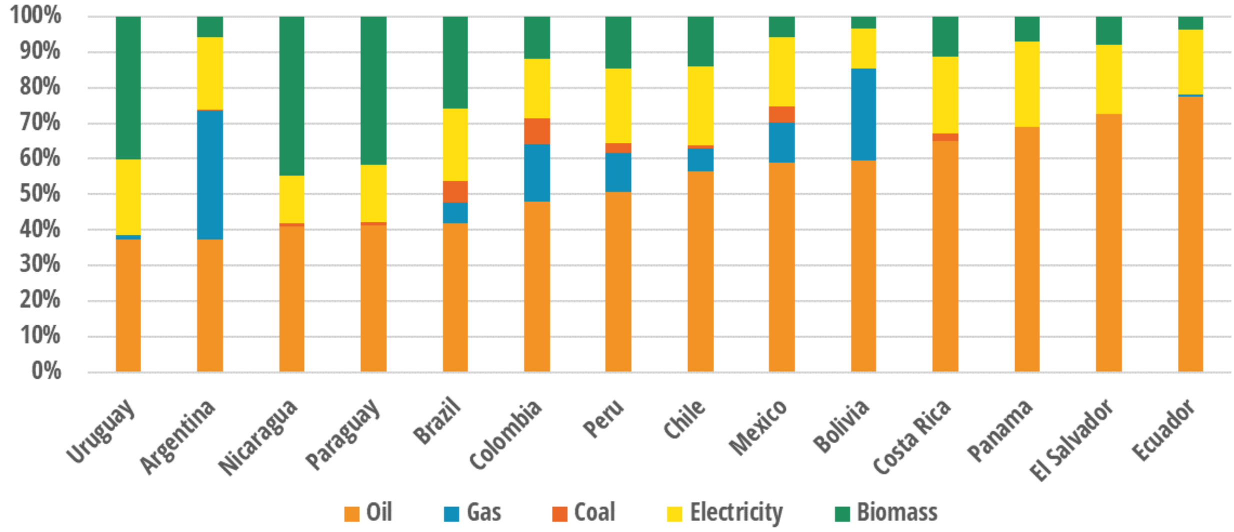
Source: BIEE Cepal

2.2.2. Share of renewables in final consumption

Oil is also the main energy source of final energy consumers in BIEE countries: between 40% and 80%, with the highest share observed in Ecuador and El Salvador and the lowest in Argentina and Uruguay (Figure 9). Gas is important in Argentina and Bolivia (36% and 26% respectively), followed by Colombia (16%). Biomass is significant in Nicaragua, Paraguay and Uruguay where it supplies over 40% of the final consumption and, to a lower extent, in Brazil (26%). Coal is generally marginal and mainly used in the steel industry (around 5% in Colombia, Brazil and Mexico).

[12] The normalisation aims at removing the fluctuation in hydropower production (and the same for wind). The methodology used to normalize the indicators is described in the methodological guidelines at https://biee-cepal.enerdata.net/en/.

Figure 9: Breakdown of final consumption by energy source (2018)

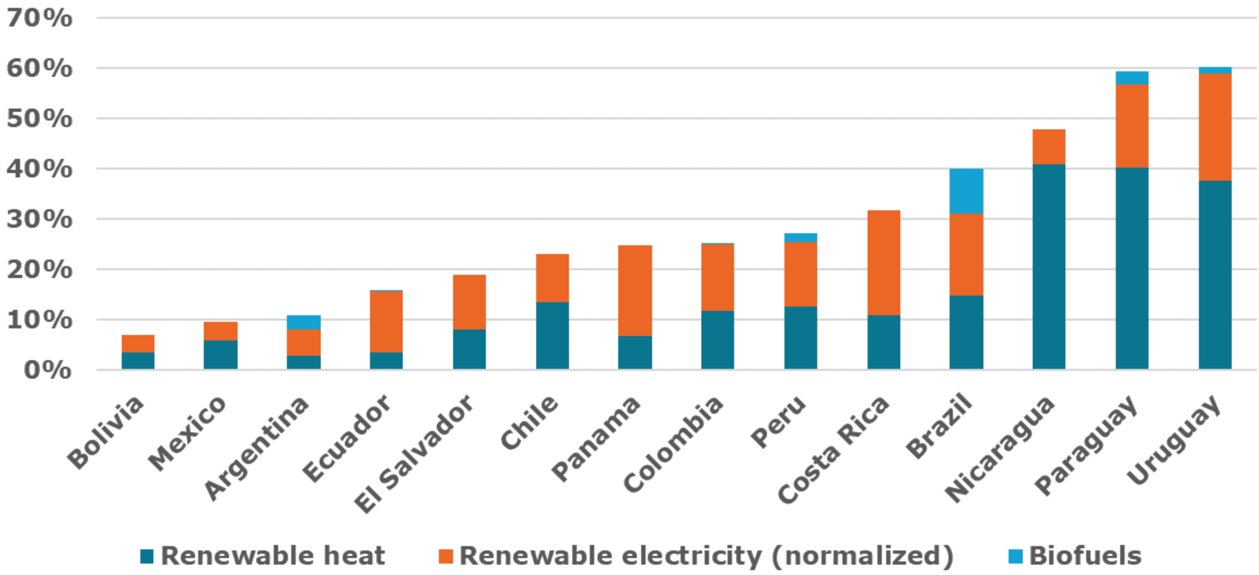


Source: BIEE Cepal

The share of renewables in the final consumption is calculated by adding to the share of biomass (solid biomass and biofuels), called "renewable heat", and the share of electricity consumed in the sector supplied with renewables ("renewable electricity"). This share of renewable electricity depends, on the one hand, on the level of penetration of electricity in the final energy consumption, and, on the other hand, on the share of electricity provided by renewables.

The share of renewables is close to 60% of final consumption in Uruguay and Paraguay. Renewable heat (mainly biomass and wastes) is the largest component in these two countries and in Nicaragua (around 40%). Renewable electricity is above 20% in Costa Rica and Uruguay. It is the dominant component in Ecuador, Panama, and Costa Rica (over two thirds of the total share of renewables). Biofuels are mainly significant in Brazil (Figure 10).

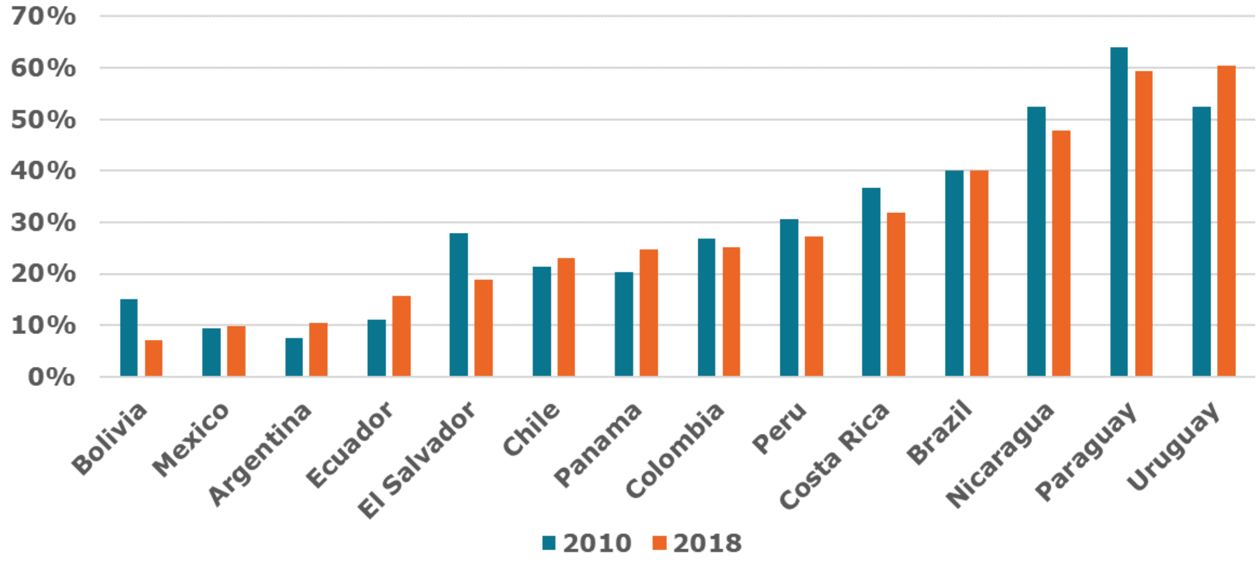
Figure 10: Share of renewables in final consumption by end-use (2018)



Source: BIEE Cepal

The highest progression of renewables in the final consumption is observed in Uruguay (+8% points) due to the increasing use of biomass in industrial sector, followed by Panama and Ecuador (+5 points) for which the hydro power generation increased strongly (Figure 11). The share of renewables is however decreasing in Bolivia, Paraguay and El Salvador (by around 10 points), as well as in Costa Rica and Nicaragua (around -5 points), mainly because of a reduced use of biomass for cooking.

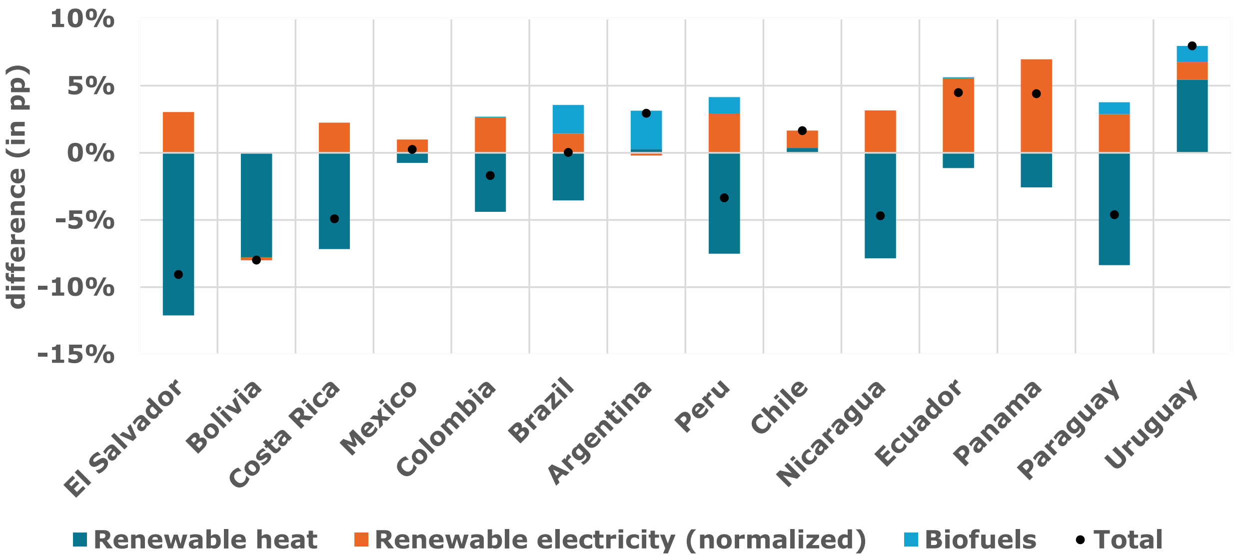
Figure 11: Share of renewables in final consumption



Source: BIEE Cepal

The share of renewables "heat" (mainly cooking) has decreased in most countries (**Figure 12**). In half of countries, it is not balanced by the penetration of renewable electricity, in particular in El Salvador and Bolivia, which explain a much lower share of renewables in 2018.

Figure 12: Components of variation of the renewable share in final consumption (2010-2018)



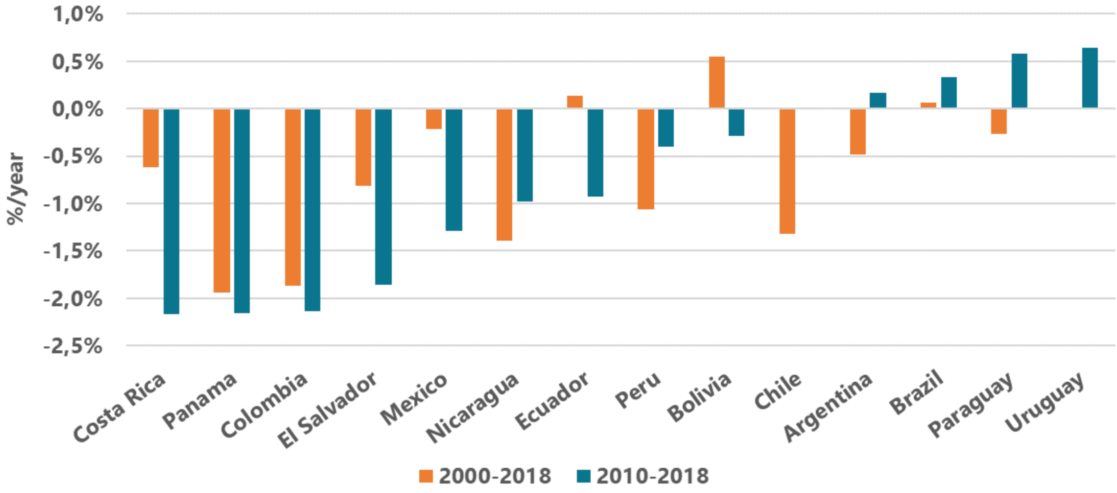
Source: BIEE Cepal

2.3. Overall energy efficiency trends

2.3.1. Trends in primary energy intensities

The most common indicator used to evaluate the overall energy performance of countries is the primary energy intensity, i.e. the total amount of energy required to produce one unit of GDP. A reduction implies an energy efficiency improvement. The intensity decreased by around 2%/year in Costa Rica, Panama, Colombia, and El Salvador. Seven countries have increased the rate of "energy efficiency improvement" since 2010: Panama, Colombia, El Salvador, Costa Rica, Mexico, Ecuador and Bolivia, with for the four later a reversing of the increasing trend observed before. However, most LACs are not in line with SDG 7.3 goal stating to "double the rate of improvement in energy efficiency by 2030", with even 4 countries with an increasing trend (Figure 13).

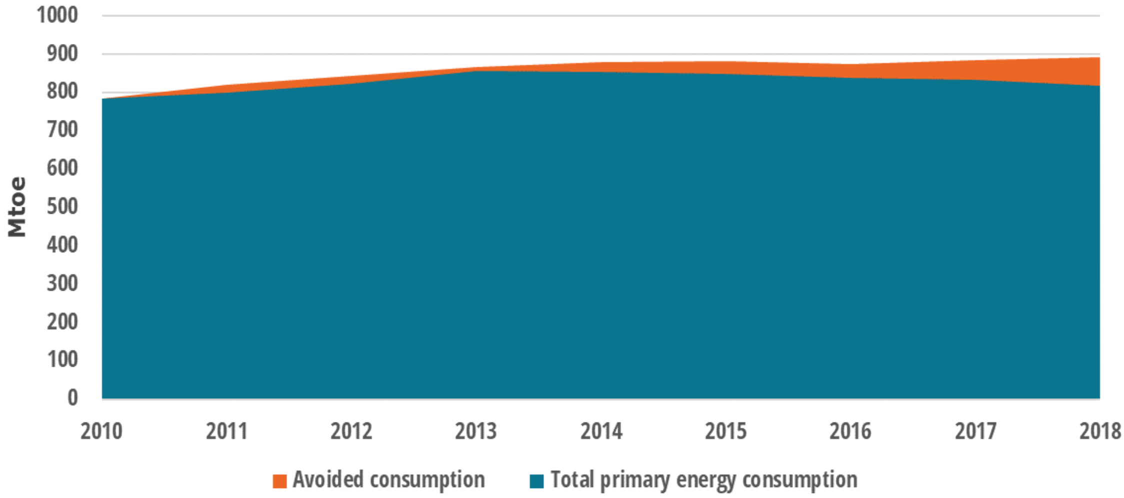
Figure 13: Primary energy intensity trends



Source: BIEE Cepal

This intensity reduction avoided an energy consumption[13] of 76 Mtoe in 2018 for Latin America as a whole, which represents 9% of the consumption. In other words, without the intensity reduction, the primary energy consumption would have been 9% higher in 2018 (Figure 14).

Figure 14: Avoided energy consumption from the intensity decrease in Latin America



Source: BIEE Cepal

2.3.2. Final energy intensity trends

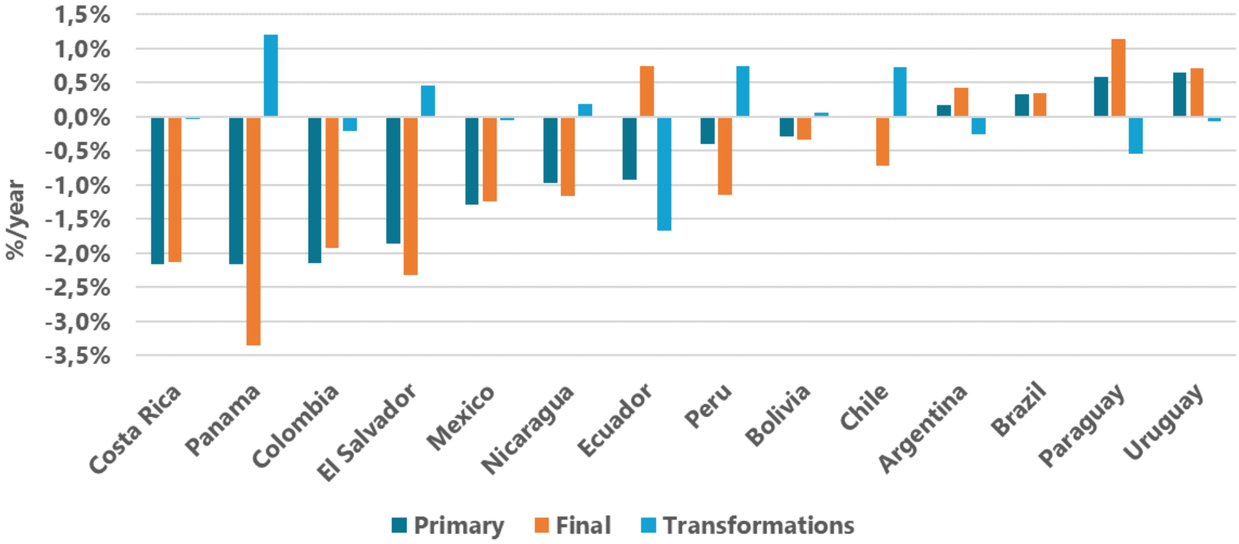
[13] The avoided primary energy consumption was calculated by Enerdata as the difference between a theoretical consumption, calculated at constant energy intensity of a base year (2010) and the observed consumption.

Trends in primary intensity are influenced by changes in energy transformations, and mainly in the power mix, whereas trends in final intensity reflect changes at sector level, where most energy efficiency actions take place.

Since 2010, final intensity has been decreasing in two third of countries, with a rhythm above 3%/year in Panama and around 2%/year in three countries (El Salvador, Costa Rica and Colombia) (Figure 15). The trend has much intensified in five countries (compared to seven countries for the primary intensity): Panama, El Salvador, Costa Rica, Mexico and Bolivia (reverse of the past trend for the four later).

In Ecuador, the final intensity has increased while the primary intensity has decreased, because of a higher share of renewables in the power mix.

Figure 15: Trends in primary and final energy intensity (2010-2018)



Source: BIEE Cepal

The primary energy intensity appears more as an indicator of "energy productivity" than a real indicator of energy efficiency, from a technical viewpoint representative of the impact of energy efficiency policies.

Indeed, energy intensity include the effect of various factors not linked to energy efficiency, such as changes in the economic structures (i.e., share of the different sectors in the GDP, see Box 2), changes in the power generation mix (thermal, nuclear and renewable), or changes in lifestyles. In this report different indicators will be presented and corrected from some of these various effects to get a clearer picture of energy efficiency trends.

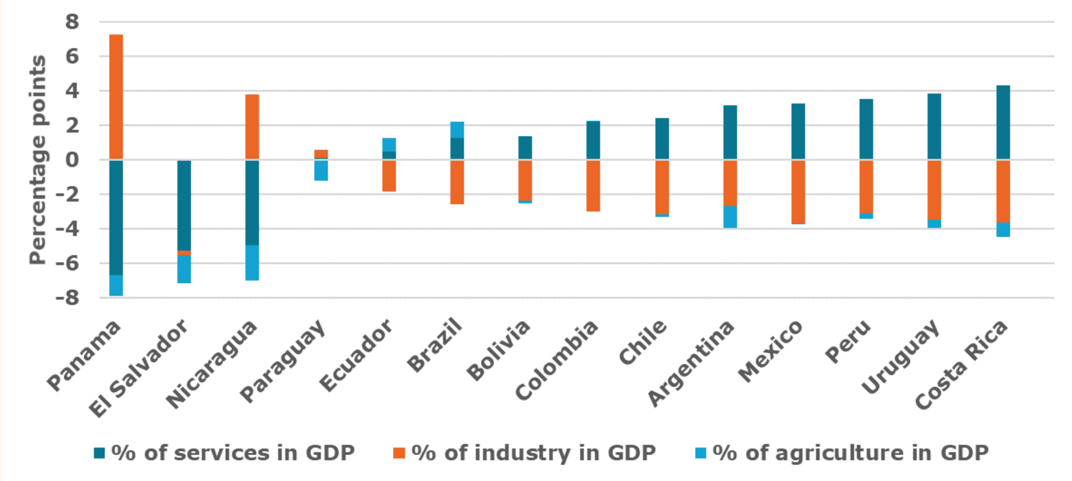
Within the framework of the European project ODYSSEE MURE, energy efficiency gains are measured by an Energy Efficiency Index calculated for each consumer sector (ODEX[14]). However, this Index requires a large amount of data and could not be calculated for most of the countries.

Box 2: Impact of changes in the economic structure on the final energy intensity

As all sectors do not have the same energy intensity, part of the variation in the final energy intensity may be due to structural changes in the GDP, i.e. in the contribution of the three main economic sectors in the GDP (agriculture, industry and services) (Figure 16).

[14] See Annex 1

Figure 16: Structural changes: variation of the sectors' share of GDP (2010-2018)

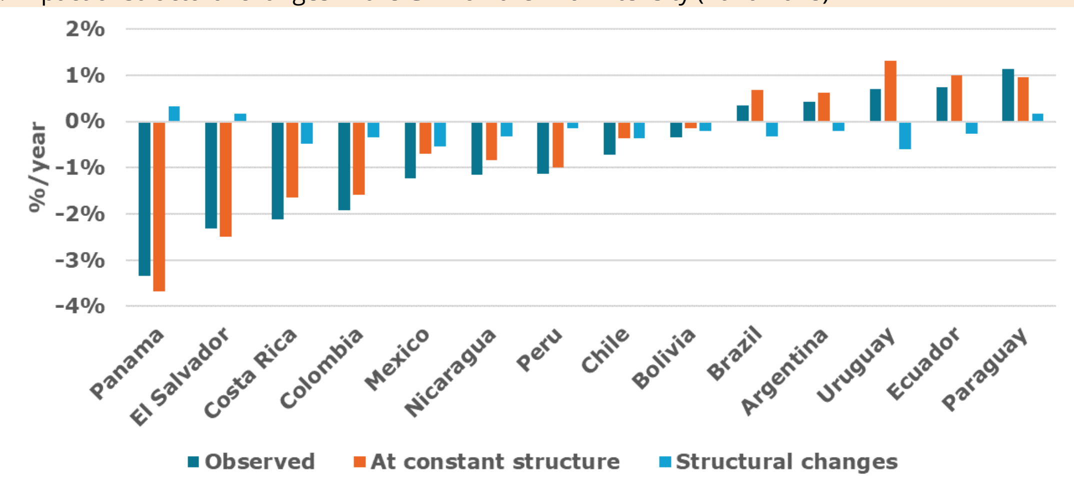


Source: BIEE Cepal

To assess the progress of energy efficiency in the different countries, it is more relevant to exclude these structural changes by calculating a final energy intensity at constant GDP structure, assuming a constant share of agriculture, industry and services in the GDP: the difference between the variations of the intensity at constant structure and the observed intensity shows the influence of these structural changes.

The impacts of structural changes over the period 2010-2018 were mainly visible in Uruguay, Costa Rica and Mexico (Figure 17): in these countries, the final intensity decreased more rapidly than the intensity at constant structure, which means that part of the energy intensity reduction was due to an increasing share of services, the less energy-intensive sector. In Panama, the increasing share of industry lowered the decrease in the final intensity. These impacts may vary from one year to the other and should always be considered to well understand the observed trends in energy intensity.

Figure 17: Impact of structural changes in the GDP on the final intensity (2010-2018)



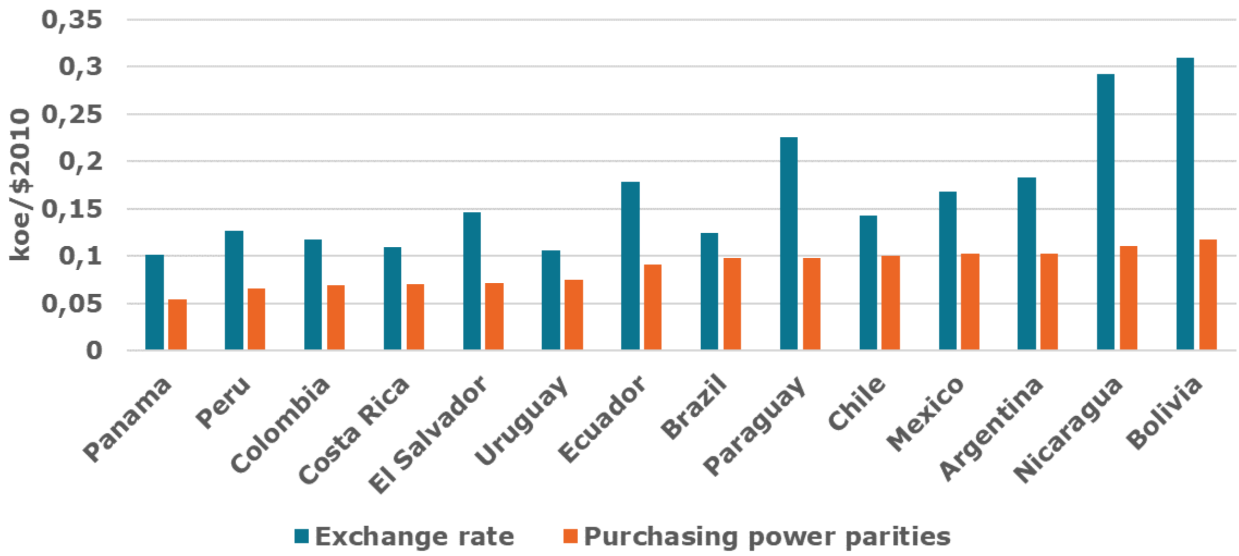
Source: BIEE Cepal

2.3.3. Comparison of energy intensities

Comparison of energy intensities is more relevant if GDP data are converted at purchasing power parities (ppp) to reflect differences in general price levels. Using ppp rates instead of exchange rates increases the value of GDP in countries with a low cost of living (case of Bolivia) and narrows the gap between countries, from a factor 3 at exchange rates between the two extremes to factor 2 at ppp in BIEE countries. The magnitude of the adjustment depends on the relative price level among countries and is greater in the less developed countries. Comparison of energy intensity is more relevant at ppp and gives a better assessment of the relative overall energy efficiency performance. Panama is the country with the lowest primary energy intensity

Even after correction for purchasing power parities, differences in energy intensities are influenced by various factors that are not linked to energy efficiency, such as: (i) the economic structures, namely the contribution of the different sectors to GDP, (ii) the power generation mix (thermal, nuclear and renewable), (iii) the importance of other transformations (as in case of Argentina, Bolivia, Ecuador or Mexico with the hydrocarbon sector), (iv) the climate, and (v) lifestyles and economic development in general. For instance, the high energy intensity Argentina, Mexico, Chile is explained by a very energy-intensive industrial sector or in Bolivia, or Nicaragua by a high use of biomass, which has a low efficiency.

Figure 18: Primary energy intensity: exchange rate versus purchasing power parity (2018)



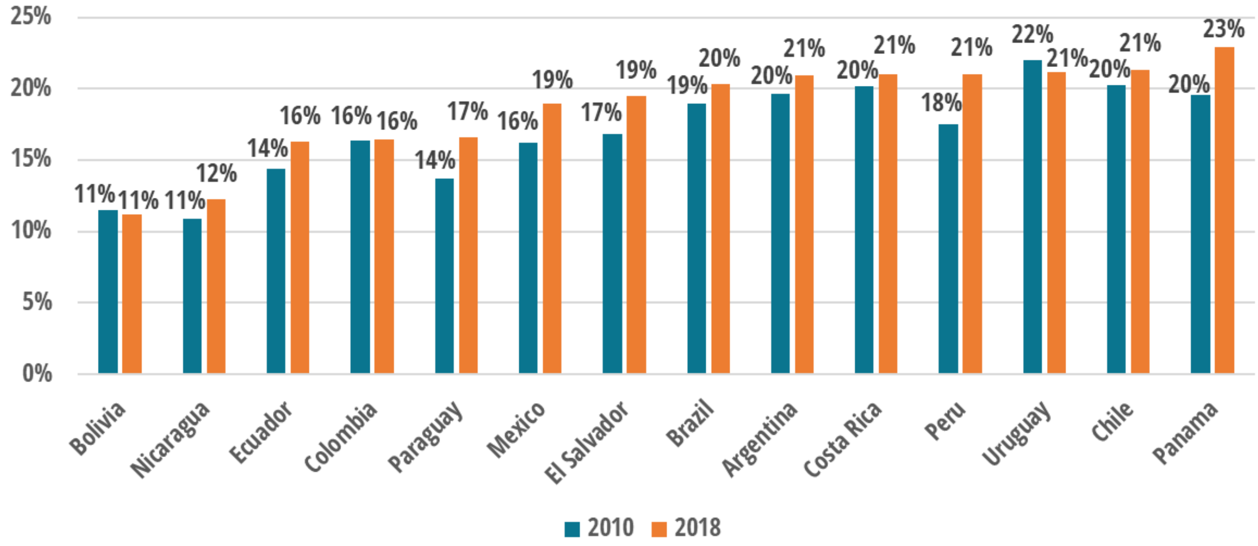
Source: BIEE Cepal

2.4. Overall trends on energy access

Electricity is at the heart of economic and social development of all these countries. Its share in the final energy consumption grew in all BIEE countries, except Bolivia and Uruguay (Figure 19). The highest increases have been observed in Peru and Panama (+3.5 points).

This increasing trend is linked to demographic change, industrialization, development of ICTs (Information and Communication Technologies) and air conditioning in services, as well as to the increasing ownership of household's appliances (refrigerators, TV and air conditioning). In the case of Nicaragua, this is also linked to the electrification of rural areas, as explained in the chapter on households.

Figure 19: Share of electricity in the final energy consumption



Source: BIEE Cepal

3. ENERGY SECTOR

3.1. Introduction

The consumption of the energy sector corresponds to the energy consumption and losses in energy transformations. It includes the net consumption for power generation[15] and other consumption and losses (e.g. oil or gas production, refining, LPG, LNG, biofuel plants, power T&D).

In countries, with no major production of fuels and with a high share of thermal power, the consumption of the energy sector mainly corresponds to losses in thermal power plants: this is the case of El Salvador, Costa Rica, Nicaragua or Panama, where power generation represents around 90% of the consumption of the energy sector. In Chile this share is around 80%.

In oil and gas producing countries, such as Argentina, Bolivia, Ecuador or Mexico, the consumption of the power sector is lower, from 40% of the total consumption of the energy sector for Bolivia to 75% for Mexico.

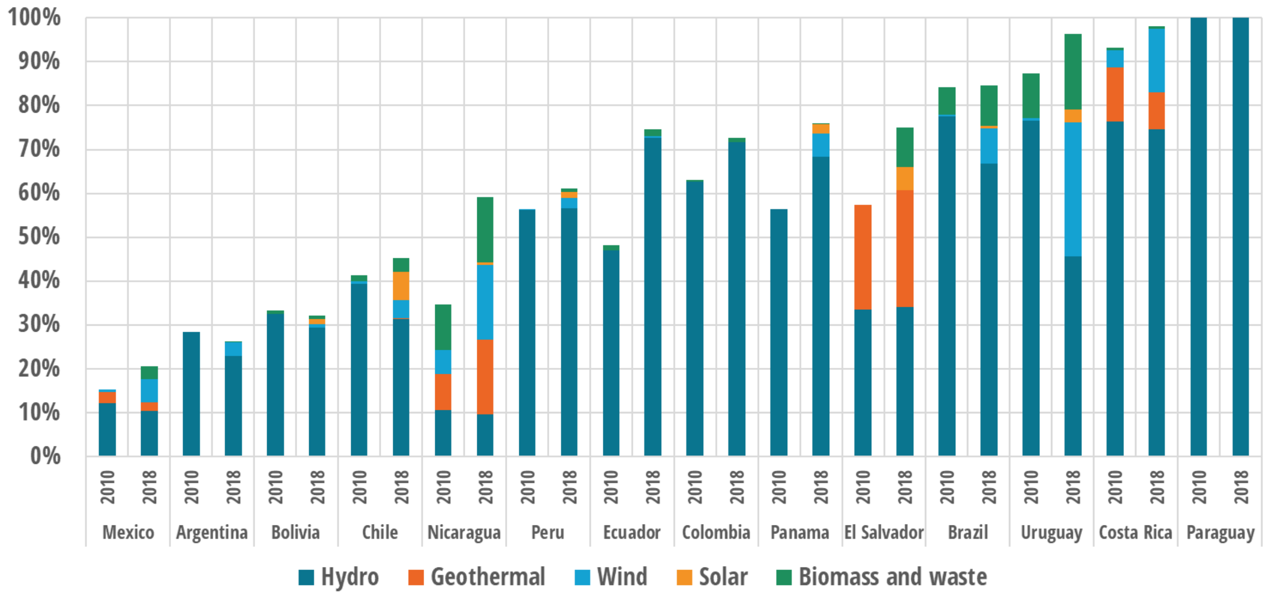
In countries with a high share of power production from renewables, power generation represent a limited share of the consumption of the energy sector (almost 0% in Paraguay, around 30% in Brazil and Uruguay).

3.2. Renewables in the energy sector

The share of renewables in the power mix ranges from 21% in Mexico to a share above 95% in Uruguay, Paraguay and Costa Rica.

This share has increased by 20 points or more in 4 countries since 2010: Ecuador (+26 points for hydro), Nicaragua (+11 points for wind, +9 for geothermal, +4 for biomass), Panama (+12 for hydro, +6 for wind, +2 for solar) and El Salvador (+9 points for biomass, +5 for both solar and hydro, +1 for geothermal). It progressed by 10 points in Uruguay (+27 points for wind, +3 points for both solar and biomass, partially offset a decrease by 28 points of hydropower) and Colombia (mainly hydro).

Figure 20: Share of renewable sources in electricity generation (normalized)

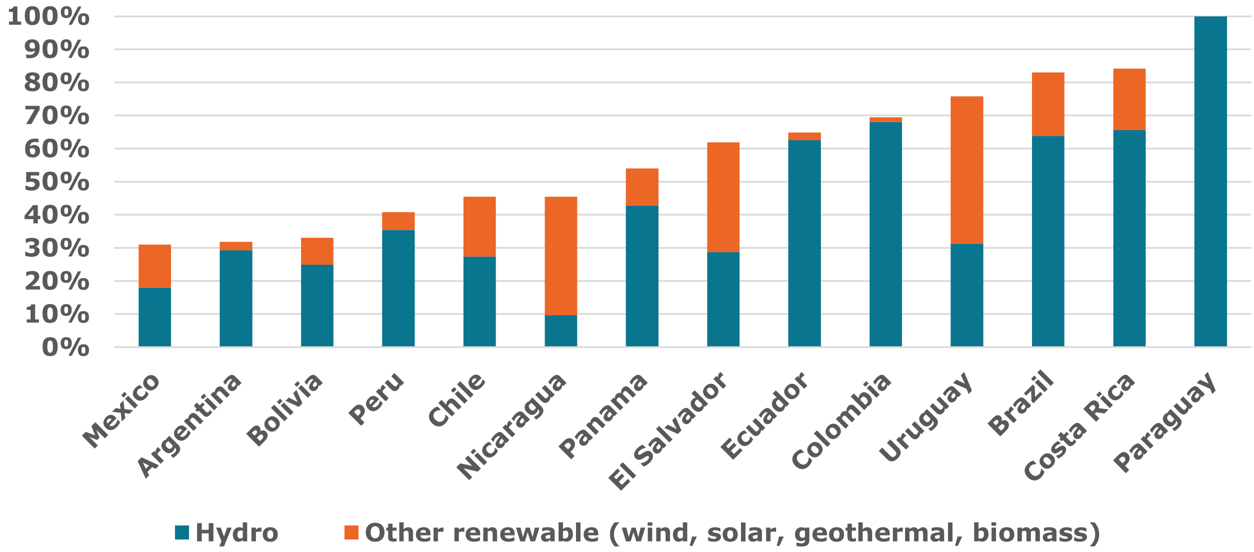


Source: BIEE Cepal

[15] The net consumption of power generation is equal to the inputs for power generation minus the electricity produced. For hydro, wind and solar PV, the inputs are equal to the output, as the efficiency of these sources are rated at 100%.

In 2018, the share of renewables in the power capacity exceeds 80% in Paraguay, Costa Rica and Brazil. Even if wind and solar are growing strongly in some countries (e.g. +30%/year for wind in Chile and Mexico since 2010), hydro remains the main renewable sources in the power capacity of most BIEE countries: more than 70% of the total capacity of renewables in 9 countries.

Figure 21: Share of renewables in electricity capacity (2018)



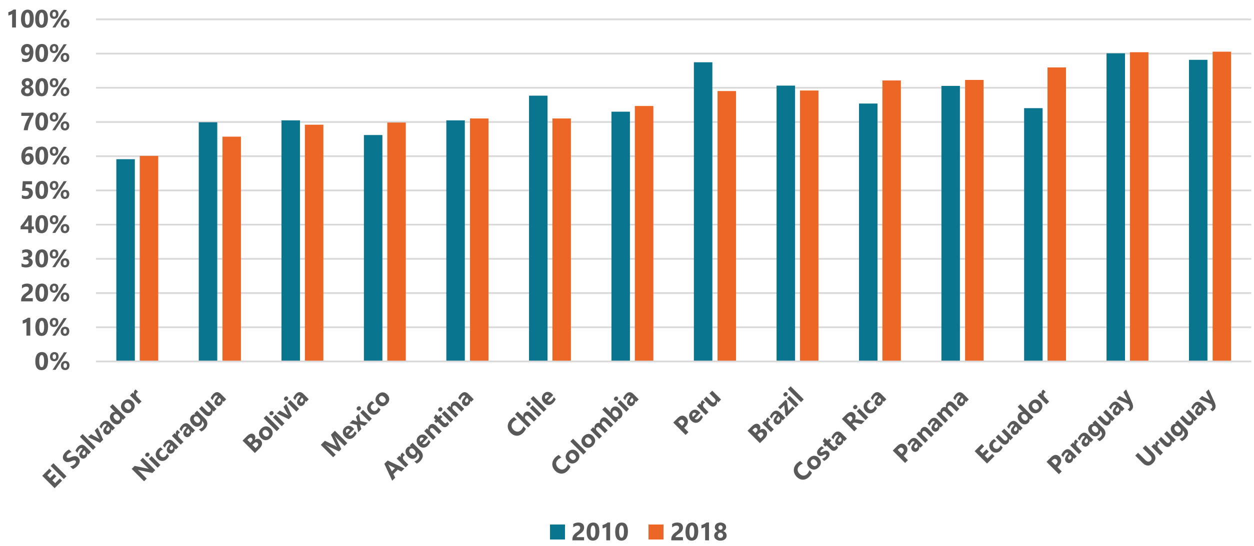
Source: BIEE Cepal

3.3. Energy efficiency in the energy sector

The overall performance of the energy sector is calculated as the ratio between the final energy consumption and the primary energy consumption: the higher the ratio, the higher the share of primary energy reaching final consumers and, therefore, the more efficient is the sector. This ratio varies from 60% in El Salvador to around 90 % in Uruguay and Paraguay, countries with a high share of renewables in the power mix. The overall efficiency is only 70% in Mexico because of the importance of the oil and gas sector and of non-renewable power generation.

The efficiency of the energy sector has increased between 2010 and 2018 in particular in Ecuador (+12 points), Costa Rica (+7 points) and Mexico (+4 points) due to energy efficiency improvement and an increase share of renewables in the power mix (Figure 22).

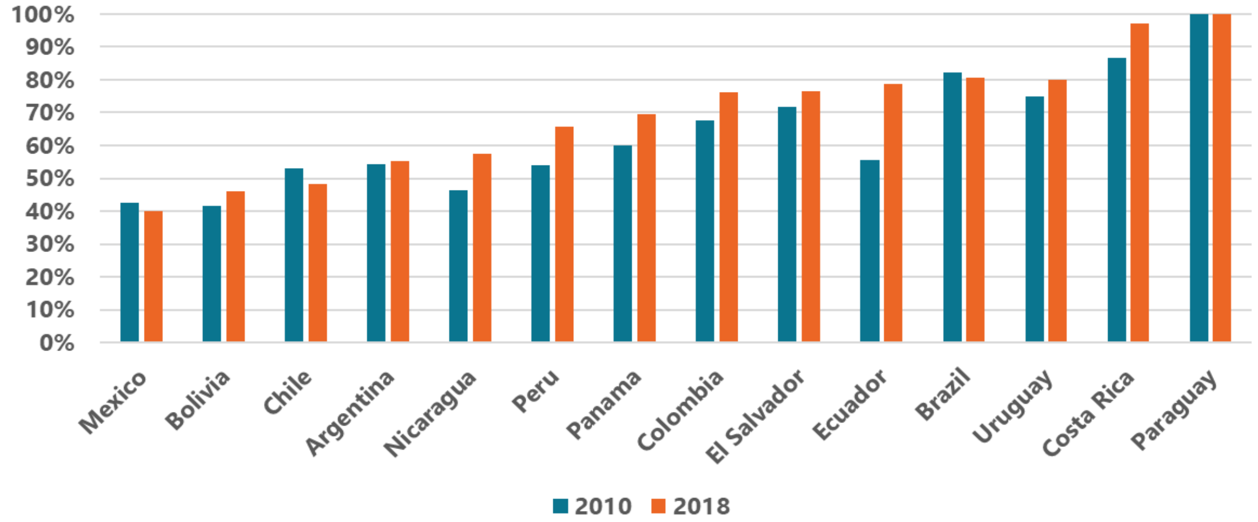
Figure 22: Overall efficiency of the energy sector



Source: BIEE Cepal

The efficiency of power generation is influenced by the electricity mix and the efficiency of thermal production. Costa Rica and Paraguay are the two countries with the highest performance (beyond 95%), because of a high share of renewables in the power mix. The countries with the highest progression are Ecuador (+23 points), Peru, Nicaragua and Costa Rica (+11-12 points), because of a sharp increase in the share of renewables in the power mix[16] (e.g. +26 points in Nicaragua) and a rapid diffusion of gas combined cycles-CCGT (Figure 23). Between 2010 and 2018, the average power efficiency decreased in Chile (-5 points) because of a higher share of coal, and in Mexico and Brazil (-2 points each) because of a lower share of renewables in their power mix.

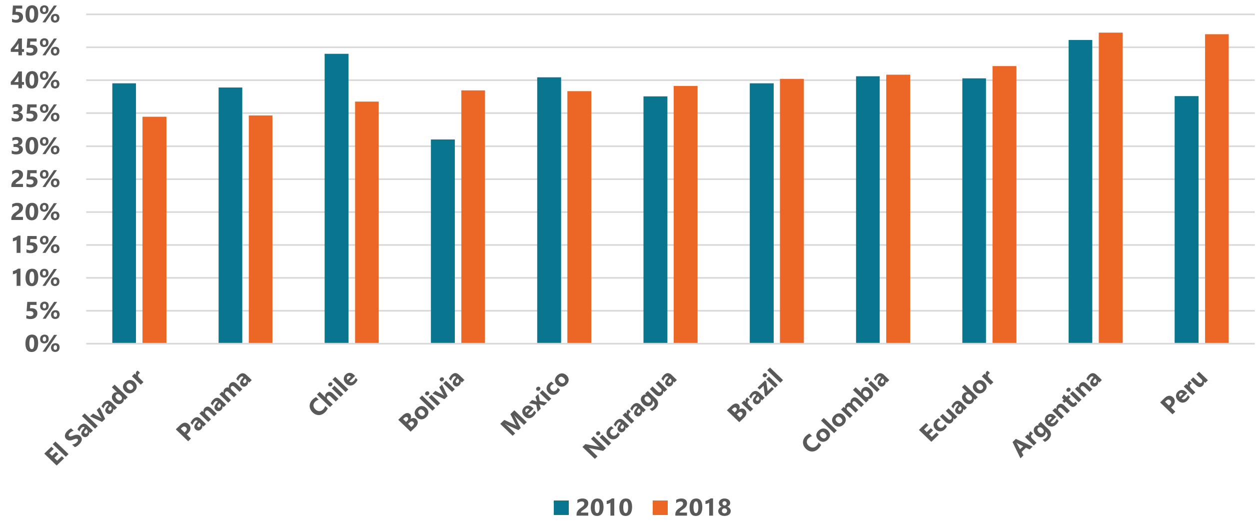
Figure 23: Efficiency of power generation



Source: BIEE Cepal

The efficiency of thermal power plants corresponds to the ratio electricity production over fuel inputs. This efficiency depends mostly on the fuel used and technology (steam turbines versus CCGT). It varies from 47% in Argentina and Peru (high share of CCGT) to 35% in Panama, El Salvador, and Chile because of coal. It has improved the most in Peru and Bolivia (shift to gas CCGT), but has decreased significantly in Chile, El Salvador, and Panama (use of coal).

Figure 24: Efficiency of thermal power plants



Source: BIEE Cepal

[16] The penetration of renewables in the power mix improves the average efficiency of power generation as they have an efficiency of 100%, compared to 33% for nuclear and between 30 and 50% for thermal generation.

Changes in the power mix, and especially the increased share of renewables, have an impact on the net consumption of the power sector, which then impact the primary energy consumption. The effect of these changes can be quantified though a decomposition of the variation of the net consumption of the power sector, as explained in Box 3.

Box 3: Impacts of energy efficiency and renewable in the energy sector

Three main factors explain the variation of the net consumption of power generation[17] :

- The increased consumption of electricity, that contribute to increase the losses in power generation, depending on the average efficiency of power generation[18];
- Changes in the power mix between energy sources with very different efficiencies ("power mix effect"), mainly between wind, hydro, PV and geothermal (100% efficiency) and thermal (from 30 to 50% depending on fuel mix and technology), plus nuclear for Argentina, Brazil and Mexico (33%);
- Variation in the efficiency of thermal power generation ("efficiency effect")

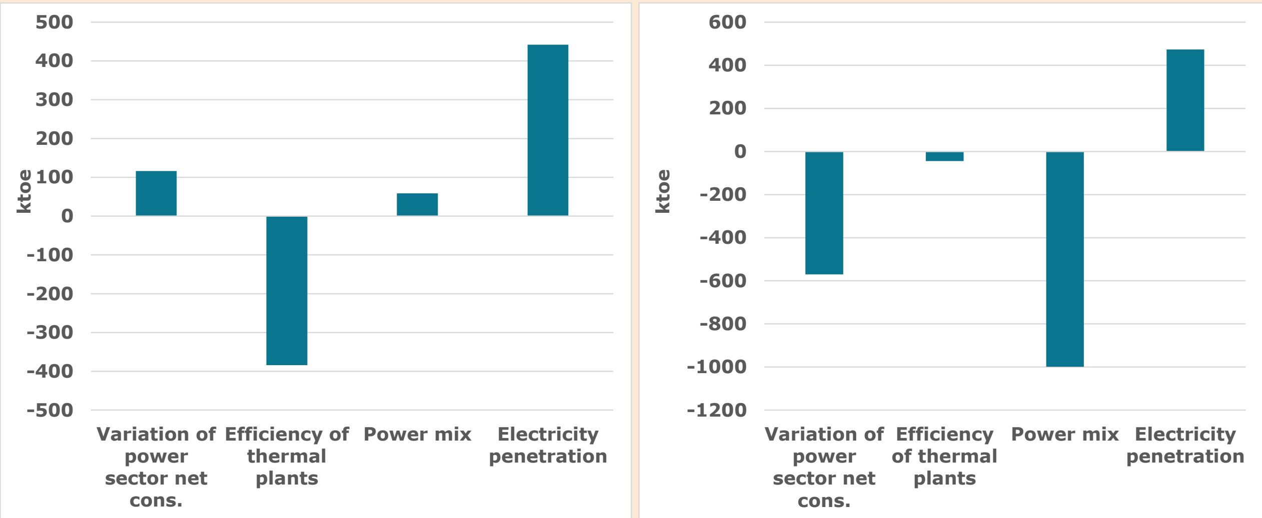
Figure 25 illustrates this decomposition in the case of Bolivia and Brazil.

In Bolivia, the increase of the thermal power generation efficiency from 31 to 39% due to the penetration of gas combined cycles between 2010 and 2018 contributed to lower the power sector consumption by around 400 ktoe. At the same time, the increasing electricity consumption (more than 4%/year over 2010-2018) more than offset this effect. The change in the power mix was not significant.

In Ecuador, the increase of renewables in the power mix from 54% in 2010 to 84% in 2018 (mainly hydro) is the dominant factor and contributed to lower the power sector consumption, and thus primary consumption, by 1 Mtoe between 2010 and 2018. The increasing electricity consumption of final consumers offset however half of this effect, resulting in a reduction of the net power sector consumption by 570 ktoe.

Figure 25: Decomposition of the net power sector consumption variation[19]

Case of Bolivia (2010-2018) — Case of Ecuador (2010-2018)



Source: BIEE Cepal

[17] Net consumption for power generation= energy input for power generation minus electricity produced.
[18] An increase in the electricity consumption of 1 Mtoe will translate into a much larger consumption of the power sector, the magnitude of which depends on the efficiency of power generation (e.g. + 2.5 Mtoe with an efficiency of 40%);
[19] The power mix and the efficiency effect are calculated as the difference between the actual consumption of the power sector in 2010 and a theoretical consumption: at 2010 power mix and 2018 power efficiency for the power mix effect; at 2010 efficiency and 2018 power mix for the efficiency effect.

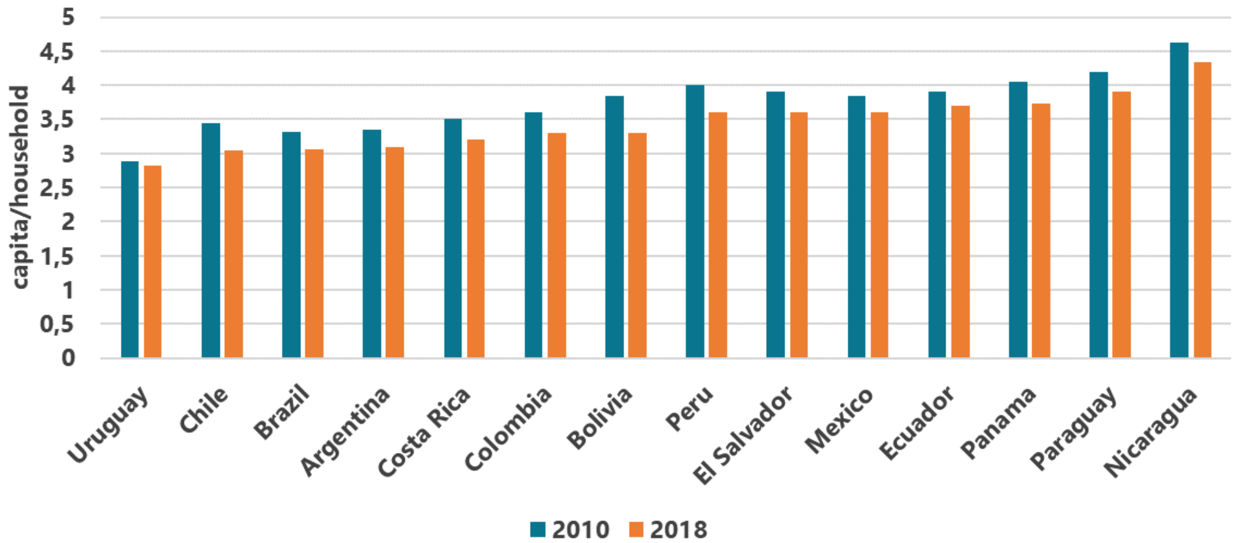
4. HOUSEHOLDS

4.1. Introduction

Households consume on average 16% of final energy consumption in BIEE countries, a share slightly lower than in 2010 (17%), with significant differences among countries (from 11% in Costa Rica to 44% in Nicaragua). In all countries, the share of household in final energy consumption decreased between 2010 and 2018.

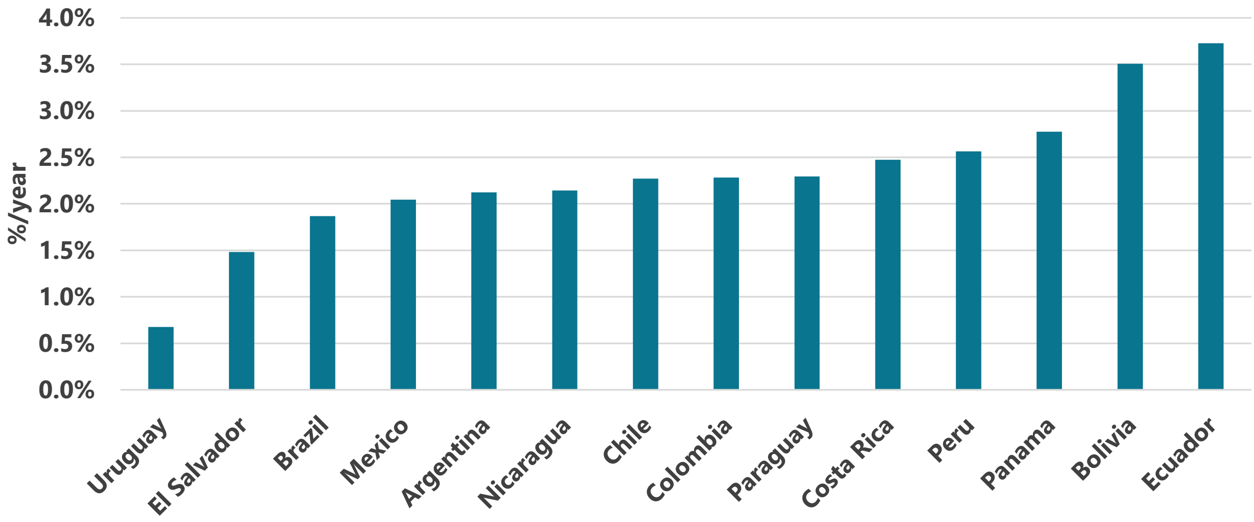
The growth in the number of households, one of the main drivers of the sector's energy consumption growth, was above 2%/year in most BIEE countries from 2010 to 2018. This was the result of the combined effect of population growth and significant decline in the number of persons per household. In 2018, this number ranged from a value slightly below 3 in Uruguay to a value above 4 in Nicaragua.

Figure 26: Trends in the average household size (persons per household)



Source: BIEE Cepal

Figure 27: Trends in the number of households (%/year, 2010-2018)

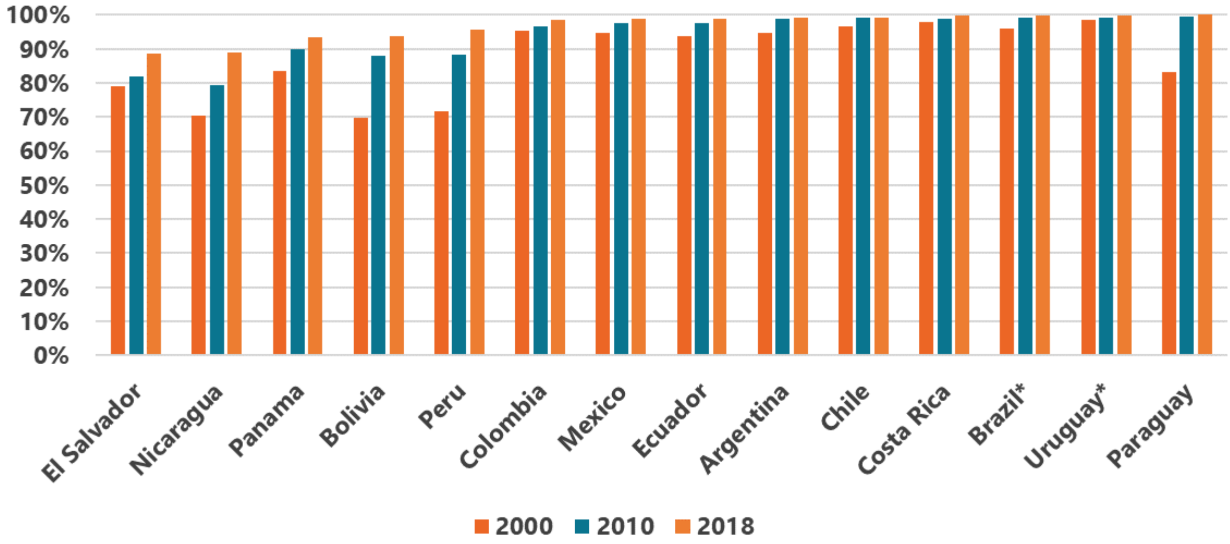


Source: BIEE Cepal

In **12 out of the 14 countries reviewed** over 93% of households had access to electricity in 2018. **In the two countries, with** the lowest electrification rate **(89% in 2018),** Nicaragua **and** El Salvador**, the rate of electrification is progressing rapidly (+9 and 7 points since 2010.**

The progression of the electrification rate is mainly driven by the electrification of rural areas: in Nicaragua the electrification rate of urban areas was already about 93% in 2000 and closed to 100% in 2018 while it was only 47% in rural areas in 2000 and increased by 22 points until 2018.

Figure 28: Access to electricity: electrification rate



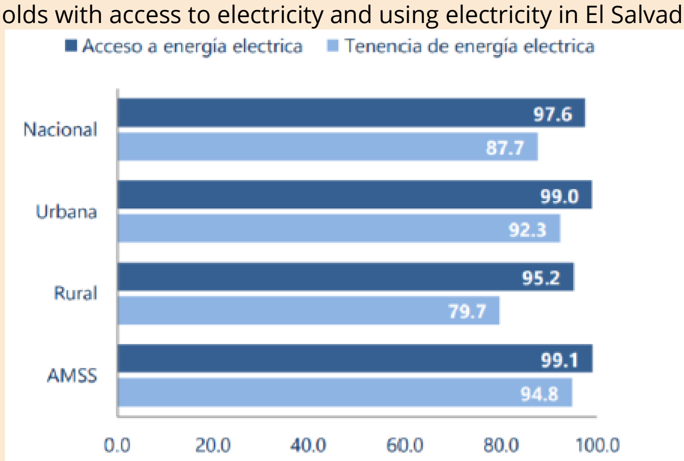
Source: BIEE Cepal; *Value in 2000: Brazil 2001 and Uruguay 2006

Box 4: How to define electricity access

The electrification rate is usually defined as the share of people or households with access to electricity. In this case, the indicator is binary (yes/no). **In some cases, households can be connected to the electricity grid without having access to electricity: in this case, the electrification rate can be overestimated. In particular, this is the case when statistics assume that when a village is connected to the electricity, all households of the village have access to electricity[20].**

In El Salvador (Figure 29), there is a significant gap between the share of households connected to the electricity grid and the share of households actually using electricity, especially in rural areas (95% versus 80% in 2019).

Figure 29: Share of households with access to electricity and using electricity in El Salvador (2019)

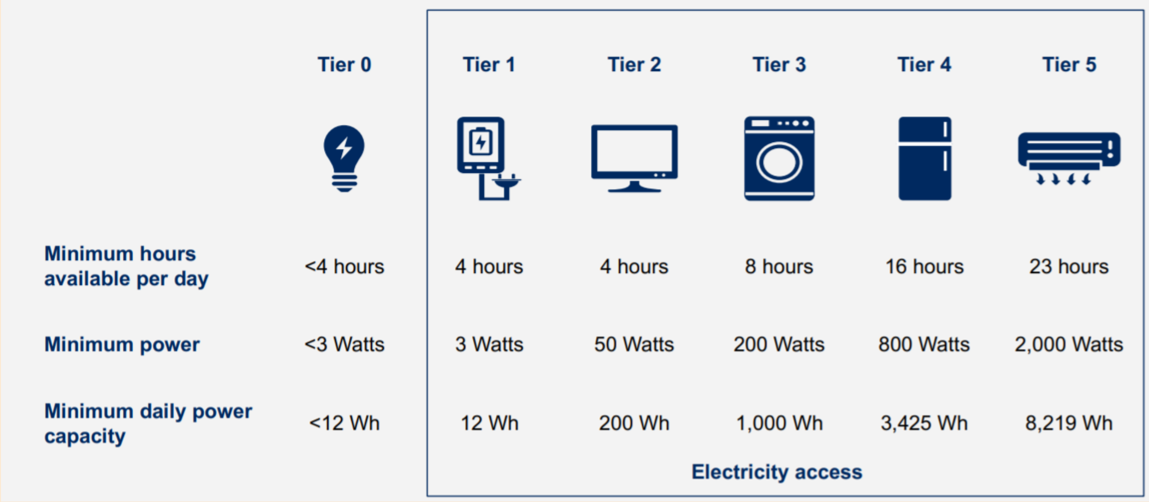


Source: Consejo Nacional de Energía, El Salvador

[20] Moreover, in some countries, the presence of an electricity connection does not guarantee that the energy supplied is reliable, affordable or of adequate quality (according to the definition of energy access stated by SDG 7.1).

Other definitions can be adopted to complement the monitoring of energy access such as the share of households having initial access to sufficient electricity to power a basic bundle of energy services. For example, the definition followed by SE4ALL is the share of household being connected to an electricity supply at Tier 1 (4 hours, 3 W and 12 Wh/day).

Figure 30: Presentation of tiers used for the definition of electricity access

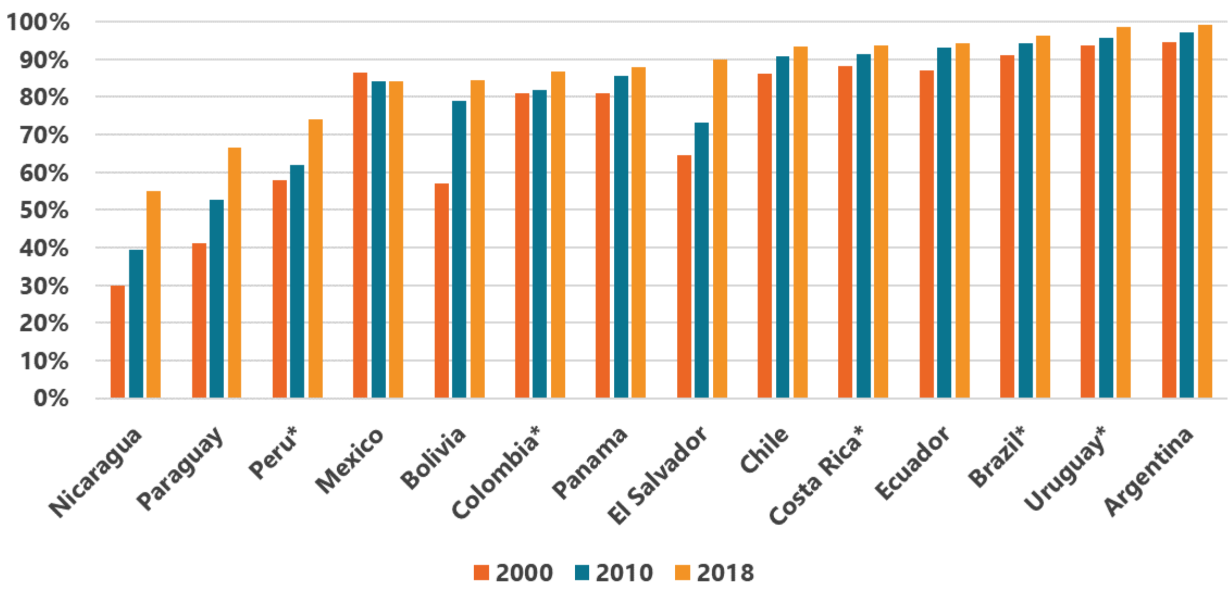


Source: SDG7 progress 2020 report, SE4ALL[21]

Another indicator of energy access stated by SDG 7.1 is the share of households with access to clean cooking technologies (i.e., cooking devices using electricity, natural gas, LPG, biogas, ethanol or solar).

More than 80% of households have access to clean cooking technologies in most countries in 2018. Argentina and Uruguay have achieved a share of around 99%. Access to clean cooking technologies remains a challenge in Nicaragua (only 55% of households with such access) and, to a lesser extent, Paraguay (67%) and Peru (74%) (Figure **31**).

Figure 31: Share of households using clean cooking technologies

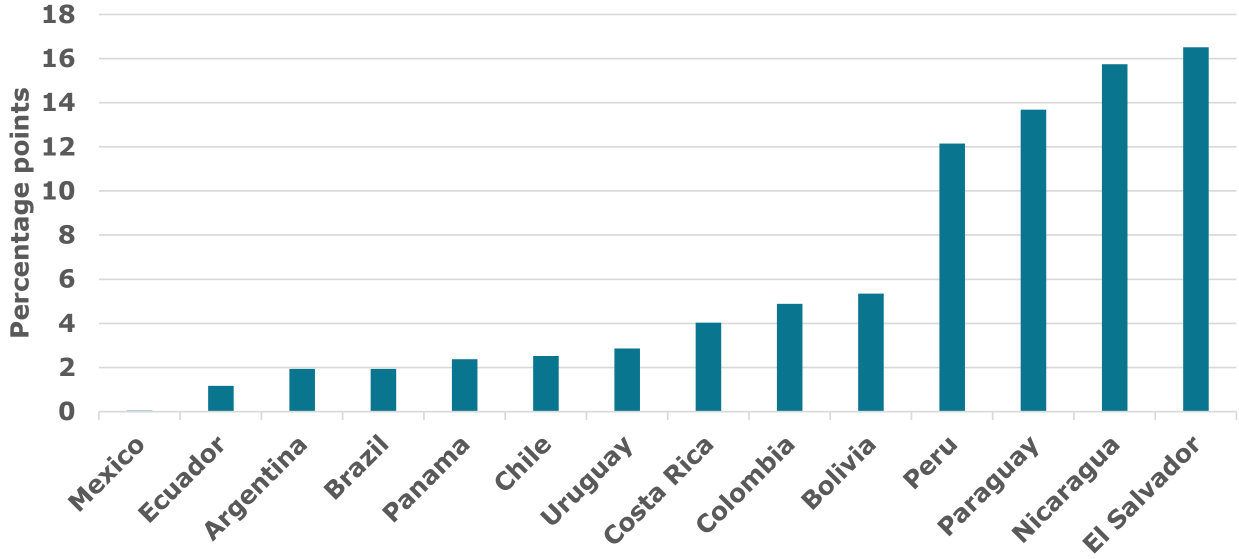


Source: BIEE Cepal ; * Peru 2008, Colombia 2008, Brazil 2001 and Uruguay 2006 instead of 2000; Costa Rica 2015 instead of 2018

[21] https://www.seforall.org/system/files/2020-10/Analysis-SDG7-Progress-2020.pdf

The three countries with the lowest share of households with access to clean cooking technologies in 2010 are gradually catching up: +16 points in Nicaragua, +14 points in Paraguay and +12 points in Peru (Figure 32). Most of the progress since 2000 in these countries has been achieved since 2010 (between 55 and 75%). The progress has been quite spectacular in El Salvador +17 points since 2010, raising the share of clan cooking to 90% in 2018.

Figure 32: Trends in the share of households with access to clean cooking technologies (2010-2018)



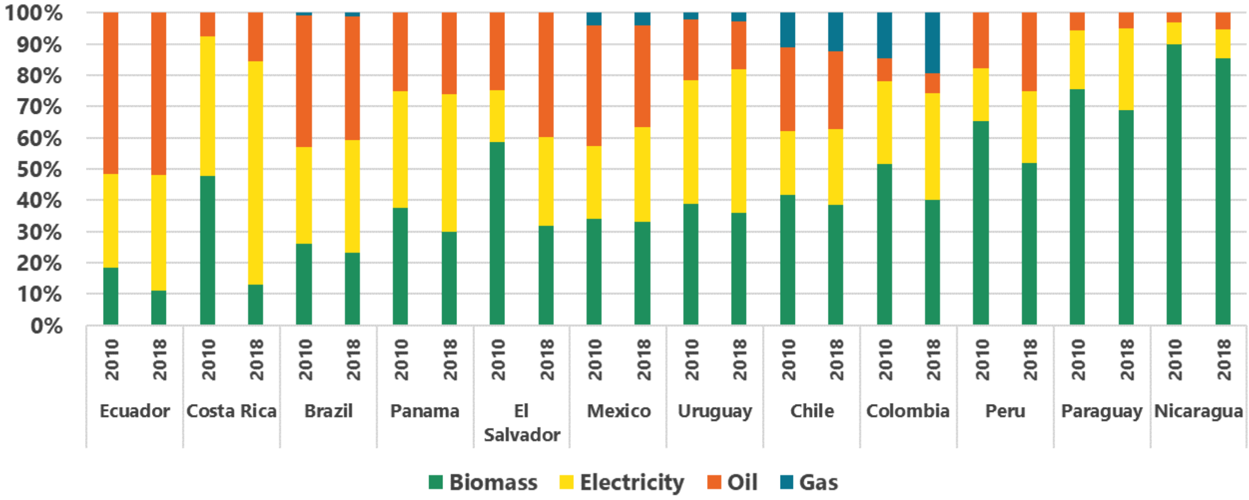
Source: BIEE Cepal

4.2. Renewables

4.2.1. Share of renewables

Over 2010-2018, the share of biomass in household consumption has decreased in all countries, by 35% points in Costa Rica, 27 points in El Salvador and 25 points in Bolivia (Figure 33). The share of electricity has grown in all countries, especially in Costa Rica (+27 points), El Salvador (+12) and Bolivia (+10). Oil, mainly LPG, has a significant share in Ecuador and Bolivia (above 50%), El Salvador and Brazil (40%).

Figure 33: Final energy consumption of households by energy source

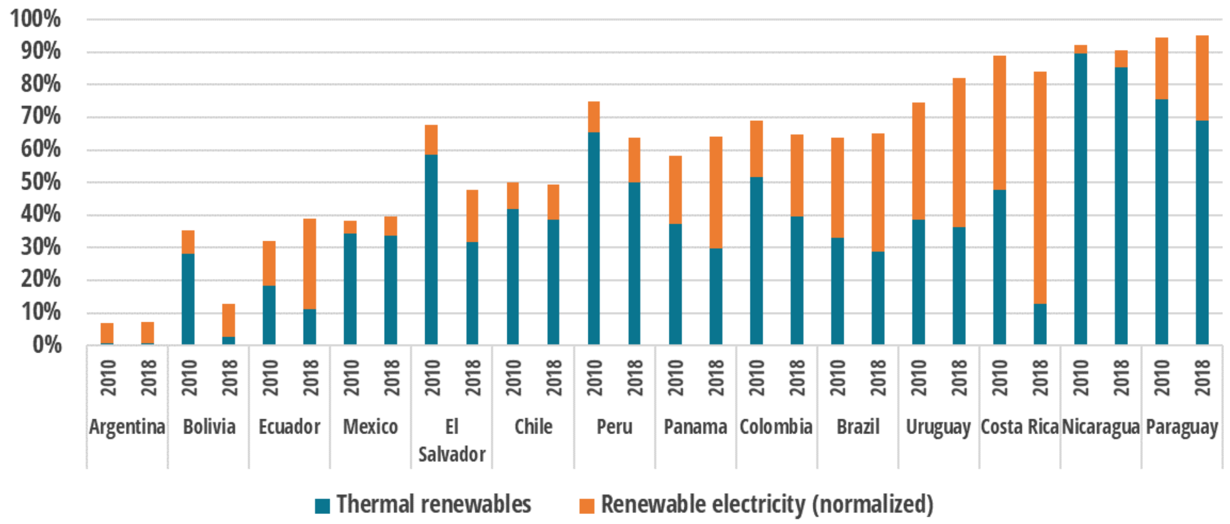


Source: BIEE Cepal

Paraguay and Nicaragua lead the way, with more than 90% of households' final consumption covered by renewable sources in 2018. Costa Rica and Uruguay are just behind thanks to their renewable electricity (84 and 82% respectively). In contrast, this share is less than 10% in Argentina (Figure 34), which use more widely natural gas for heating, water heating and cooking.

In about half of the countries, the share of renewables in households' consumption has decreased over 2010-2018, as the use of biomass decreased faster than the rise in the share of renewable electricity. It declined by around 20 points in El Salvador and in Bolivia. In Panama, Uruguay and Ecuador, the decline in biomass was however more than offset by the penetration of renewable electricity leading to an increase of the share of renewables (around +6-7 points).

Figure 34: Renewable share in household consumption

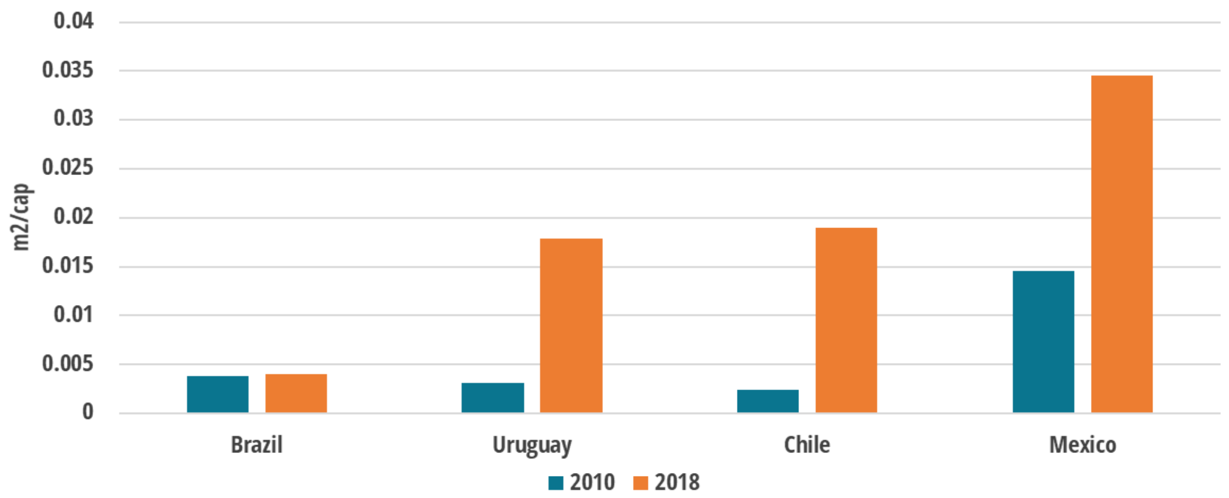


Source: BIEE Cepal

4.2.2. Solar water heaters

The installed area of solar water heaters is low in LACs, especially in comparison to European countries with similar solar irradiation. It is of 4 m2/1000 inhabitants in Brazil, 18 m2 in Chile and Uruguay and 35 m2 in Mexico, compared to 440 m2/1000 inhabitants in Greece (2018). This is explained by lower needs for hot water and less support policies, except in Uruguay and Argentina. The area of solar heaters is increasing by over 10%/year in Chile, Uruguay and Mexico.

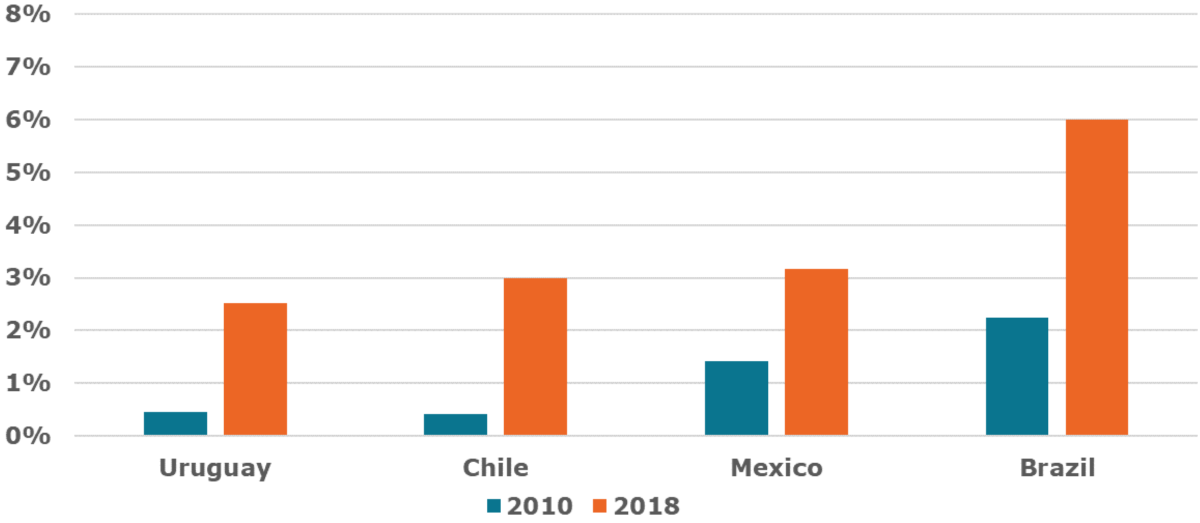
Figure 35: Area of solar water-heaters per capita



Source BIEE, Cepal

Even if Brazil has the lowest area of solar water heaters per capita, it has the highest penetration of solar water heaters with 6% of households equipped in 2018), compared to around 3% in Mexico, Chile and Uruguay (Figure 36).

Figure 36: Share of households equipped with solar water heaters



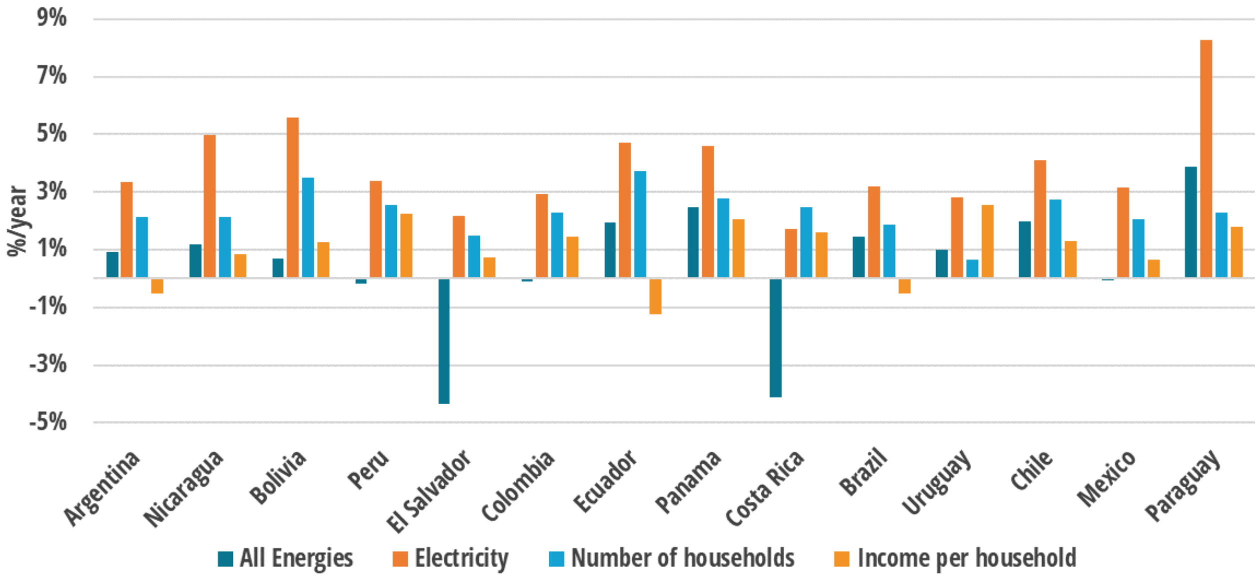
Source BIEE, Cepal

4.3. Energy efficiency trends

4.3.1. Overall trends

In all countries the household electricity consumption grew faster than the total consumption (Figure 37). This growth is directly linked to the progression of the equipment ownership with the household income, to the increase in electrification rate and to substitution of fuel by electricity.

Figure 37: Energy consumption, household income and number of households (2010-2018)

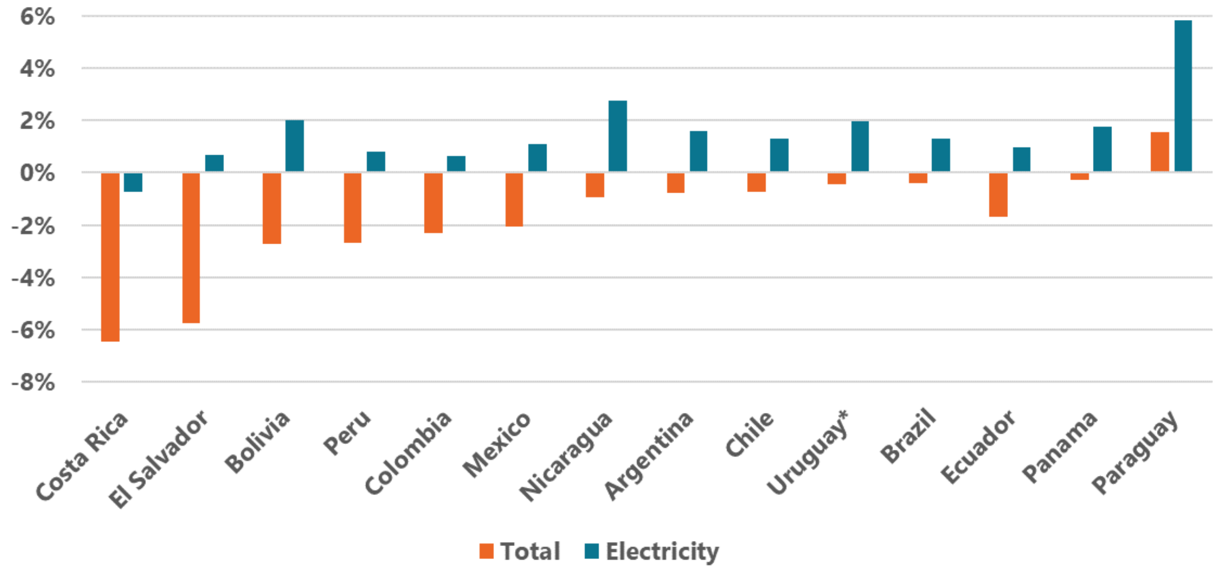


Source: BIEE Cepal

The average consumption per household has been decreasing in almost all BIEE countries between 2010 and 2018 mainly because of the substitution of biomass by more efficient fuels for cooking (Figure 38).

The electricity consumption per household has increased significantly in Paraguay (around 6%/year) and to a lesser extent in other countries (1-3%/year) with the growth in equipment rates (refrigerators, TV, ICT, AC, water heater) and electrification. In Costa Rica, the decrease may be linked to energy efficiency measures implemented for appliances and lighting.

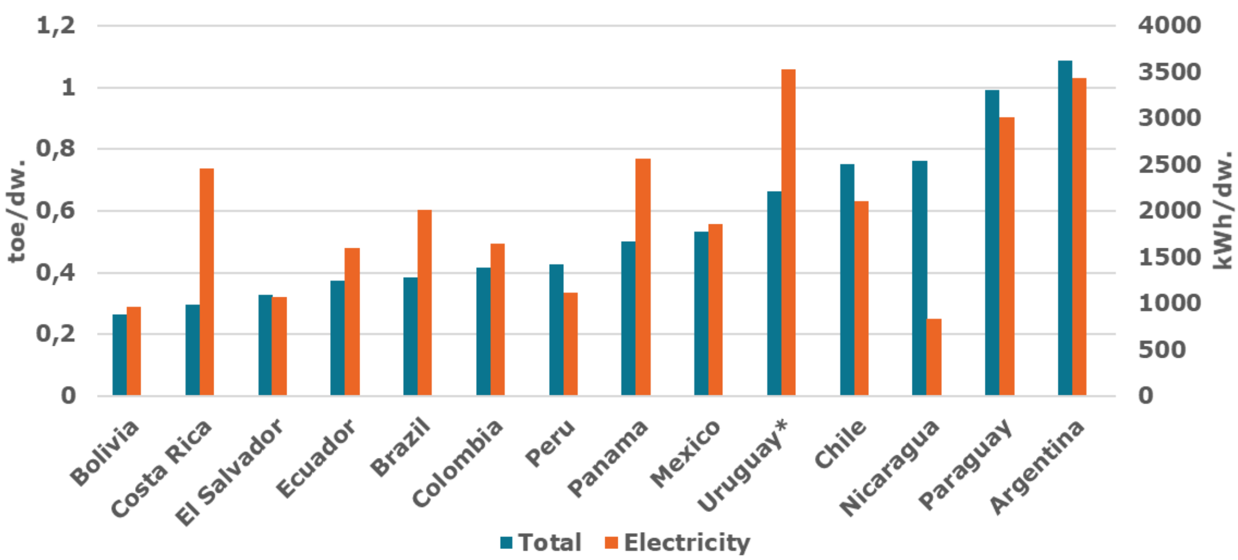
Figure 38: Variation of total and electricity unit consumption of households (2010-2018)



Source: BIEE Cepal

The average unit consumption per household varies a lot among countries, from 0.3 toe in Bolivia to around 1 toe in Paraguay (because of a large use of biomass) and 1.1 toe in Argentina (high space heating needs). The average electricity consumption per household varies from around 850 kWh in Nicaragua to around 3500 kWh in Argentina and Uruguay.

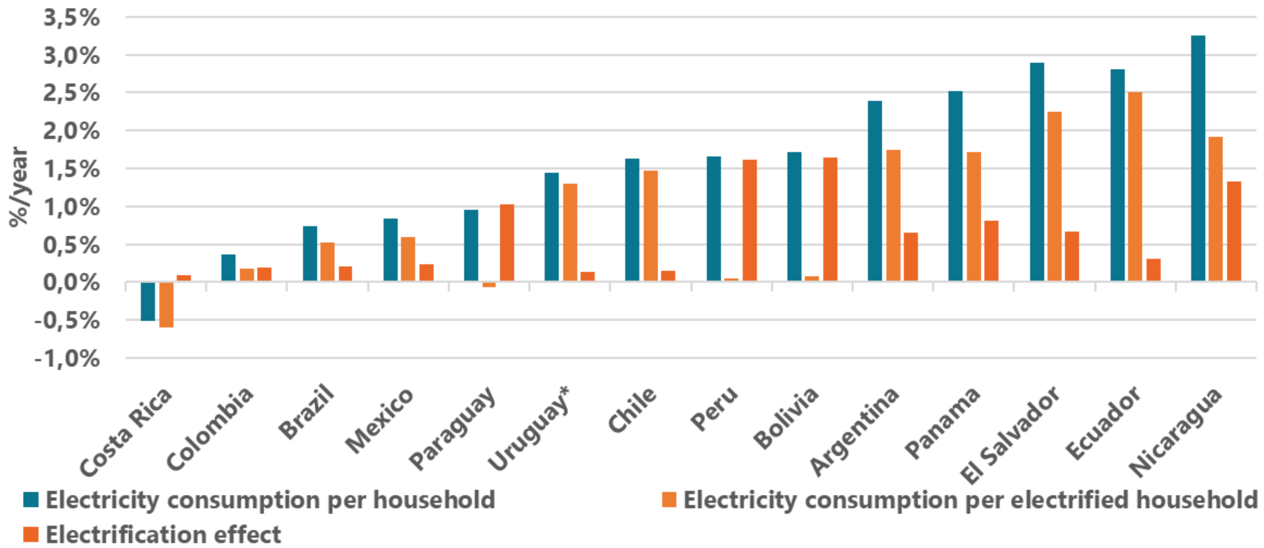
Figure 39: Total and electricity consumption per household (2018)



Source: BIEE Cepal; dw: dwelling (=household)

In Peru, Bolivia and Paraguay, most of the increase in the electricity consumption per household between 2000 and 2018 is due to the electrification of rural households: the consumption per electrified household has almost not changed. In Nicaragua, the household's electrification explains one third of the increase in the consumption per electrified household.

Figure 40: Unit electricity consumption per household: impact of electrification (2000-2018)

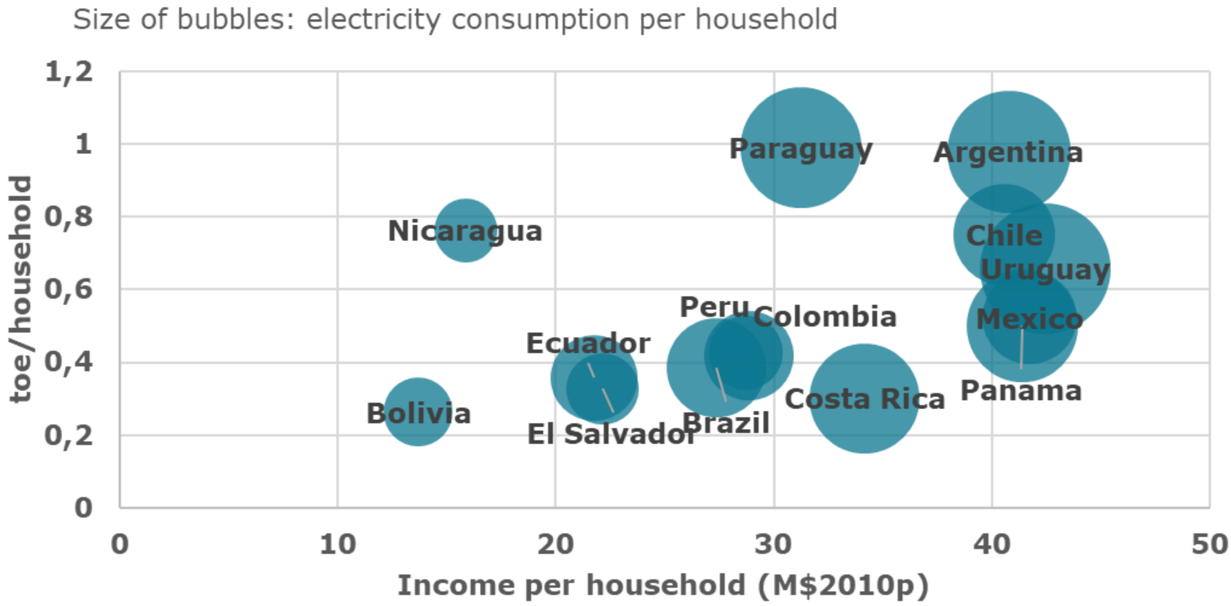


Source: BIEE Cepal; *Uruguay: 2006-2018

Uruguay has the highest income per household and one of the highest electricity consumption per household. Argentina and Paraguay have also a high electricity consumption per household. At the same level of income (abscise axis), there is a significant dispersion in the consumption per household (ordinate axis).

However, we observe a correlation between the income per household and the electricity per household: the lower is the income per household (abscise axis), the lower is the electricity consumption per household (size of bubbles).

Figure 41: Electricity consumption per household and income (2018)



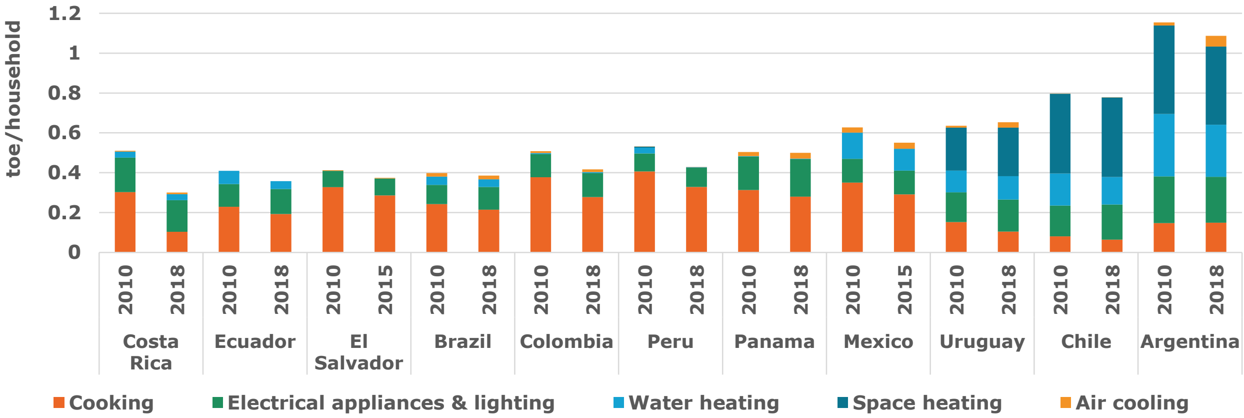
Source: BIEE Cepal

4.3.2. Energy efficiency trends by end-use

More in-depth analysis, especially to well monitor energy efficiency trends, imply to have a disaggregation of the consumption by end-use and main appliances.

The energy consumption per dwelling is generally the highest in countries with space heating needs, such as Chile, Uruguay and Argentina. In these countries, space heating is generally the dominant end-use in the energy consumption, respectively 51%, 37% and 36%, In other countries, cooking represents over half the consumption of households (Figure 42).

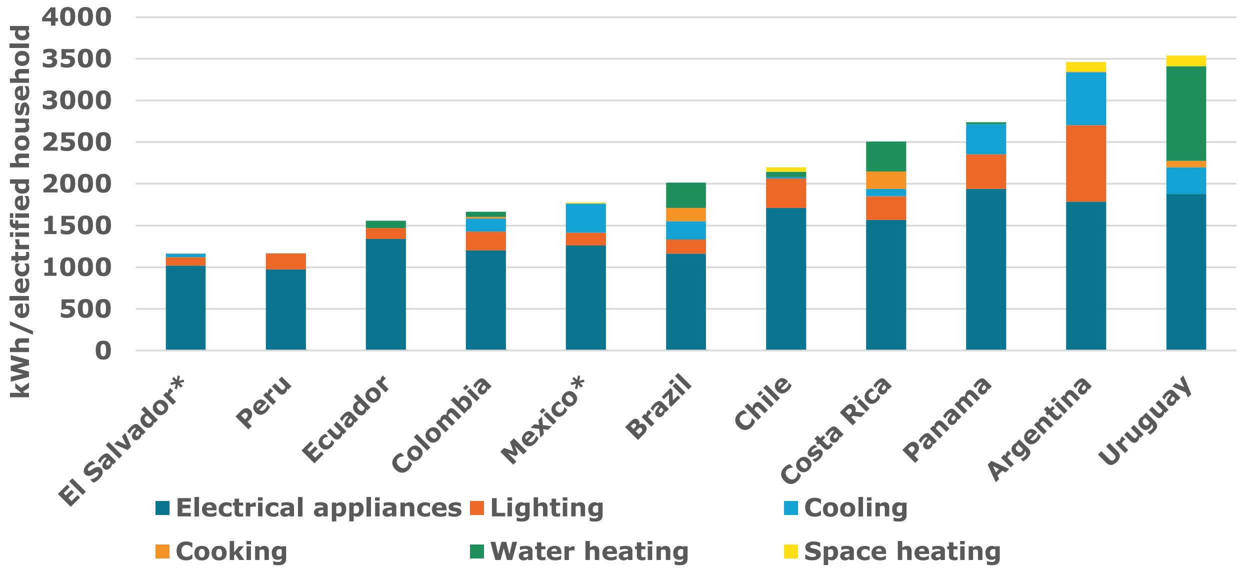
Figure 42: Energy consumption per dwelling by end-use



Source: Brazil, Mexico (2015), El Salvador (2015), Uruguay: national sources; others: Enerdata estimates[22]

Most of the electricity used by households is for appliances, such as refrigerators, or TV, up to 71% in Panama, 53% in Uruguay and 52% in Argentina[23]. Water heating has also a significant share in Uruguay (30%). The share of cooling is the highest, among countries with data, in Mexico and Argentina (20 and 18% respectively) (Figure 43).

Figure 43: Electricity consumption by end-use per electrified household (2018)



Source: Brazil, Mexico (2015), El Salvador (2015), Uruguay: national sources; others: Enerdata estimates

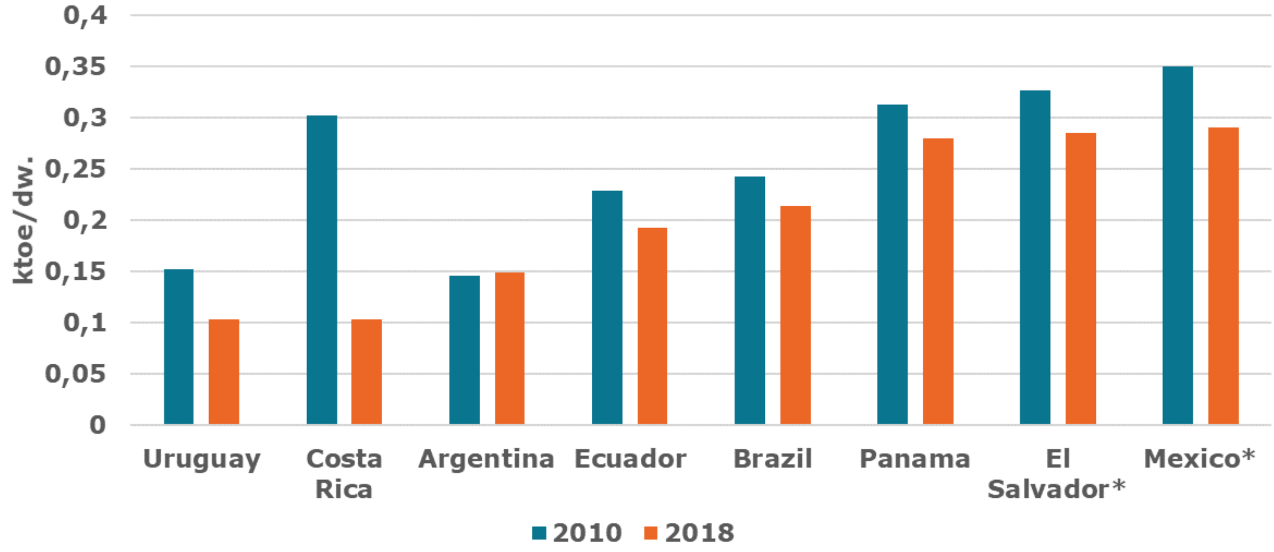
[22] Enerdata developed a methodology based on data provided by national teams from household surveys or useful energy balances on equipment ownership and specific consumption (documentation at https://biee-cepal.enerdata.net.

[23] Specific electricity consumption around 1800-1900 kWh/household in these three countries.

4.3.2.1. Cooking

The unit consumption per dwelling for cooking depends generally on the share of biomass: the higher is the share of biomass, the higher is this unit consumption. It varies from around 0.1 toe per dwelling in Uruguay to around 0.3 toe per dwelling in Mexico and El Salvador in 2018. In all countries with data by end-use, the unit consumption for cooking per dwelling decreased since 2010, except for Argentina. This is explained by the substitution from biomass with modern fuels (LPG, gas and electricity) that are much more efficient.

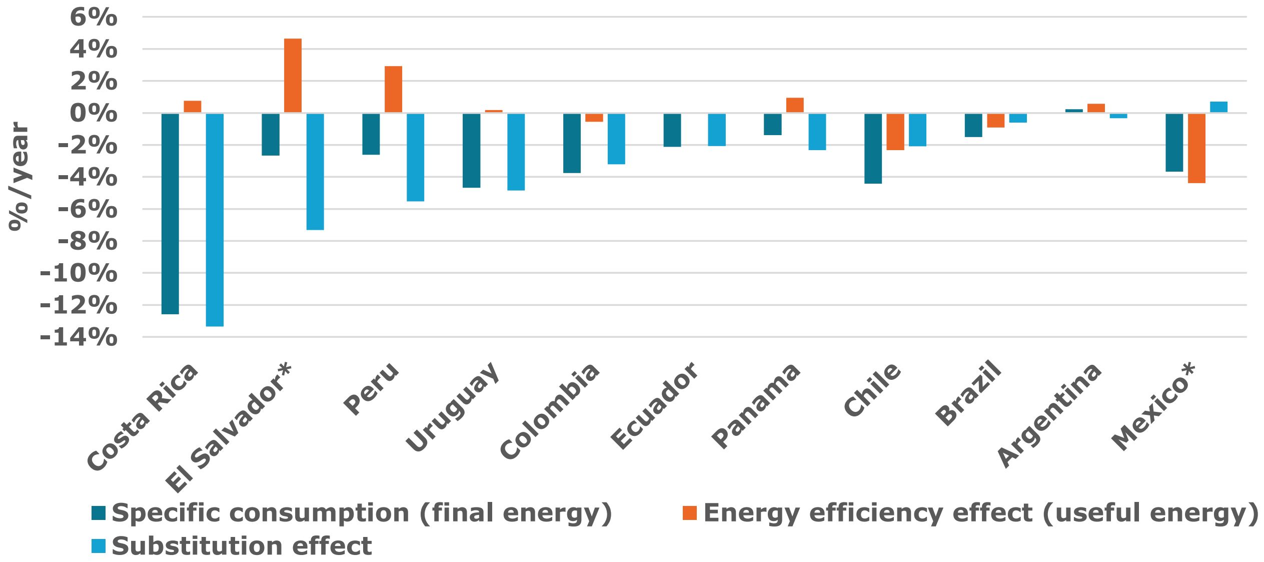
Figure 44: Unit consumption per dwelling for cooking



Source: BIEE Cepal; *El Salvador and Mexico: 2010-2015

In Costa Rica, Uruguay, Colombia and Ecuador, substitutions explain most of the variation. In Brazil, only a third of the decrease (-1.5%/year) is due to fuel substitution, the remaining two thirds were achieved through energy efficiency improvements[24].

Figure 45: Impact of fuel substitution on the specific energy consumption for cooking (2010-2018)



Source BIEE, Cepal; *El Salvador and Mexico: 2015

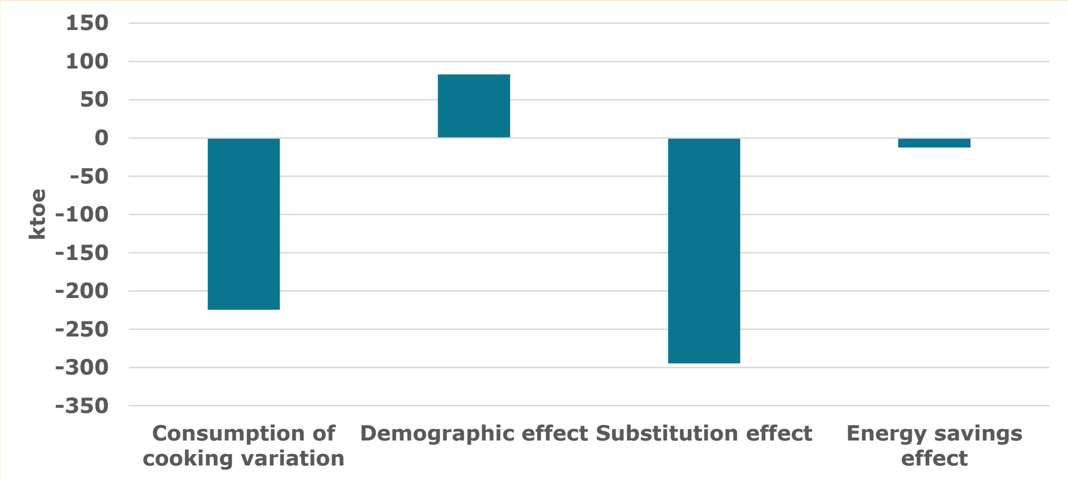
[24] The annual variation of the specific consumption has been divided into two components: the substitution effect and the energy efficiency effect. The later is calculated from the variation of the specific consumption in useful energy. The substitution effect is equal to the annual variation of the specific consumption minus the energy efficiency effect.

Box 5: Impact of fuels substitution on cooking consumption

In countries with a rapid transition from biomass to modern fuels, this substitution had an effect on the final energy consumption variation by lowering its growth. The impact on cooking consumption can be estimated by decomposing the variation of the energy consumption for cooking using the calculation shown in Figure 46.

In the case of Costa Rica, for instance, substitution of LPG and electricity to biomass (shares of LPG and electricity increasing from 12% to 45% and 7% to 17% respectively) contributed to decrease the energy consumption for cooking by around 300 ktoe between 2010 and 2018 (Figure 46). The growth in the number of households however offset part of these savings and contributed to increase this consumption by 80 ktoe. As a result, the energy consumption for cooking decreased by 230 ktoe over the period (e.g. 10%/year).

Figure 46: Decomposition of the variation of cooking consumption in Costa Rica (2010-2018)

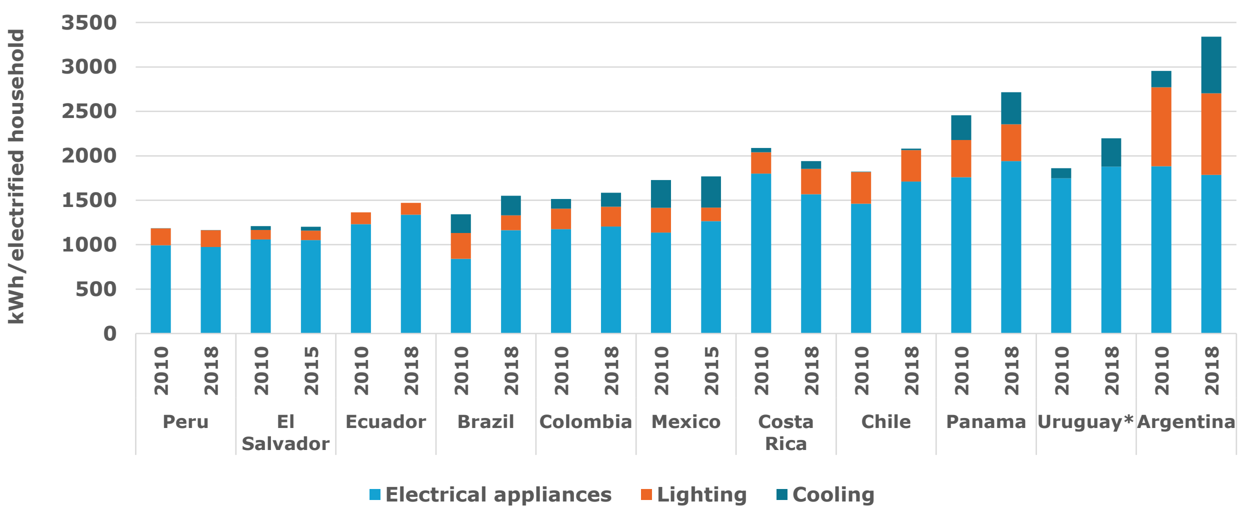


Source BIEE, Cepal

4.3.2.2. Electrical appliances, lighting and cooling

Electrical appliances represent the bulk of the consumption of electricity for captive uses (i.e. excluding thermal used such as cooking or water heating, for which alternative fuels can be used) (Figure 47): from 53% in Argentina for 2018 to 91% in Ecuador.

Figure 47: Specific electricity consumption for electrical appliances, lighting and cooling



Source BIEE, Cepal; * Uruguay: lighting included in electrical appliances

Based on the trend on the specific consumption for appliances and lighting and cooling it is possible to assess energy efficiency trends for these appliances and to calculate energy savings.

In particular an Energy Efficiency Index can be calculated to summarise the overall trends (see methodology in Annex 1).

It is also possible to explain the variation of the consumption for a given appliance or end use, as well as for the total consumption of households, using a so-called decomposition method. In this decomposition, the increase in the electricity consumption of household appliances can be explained from three main factors:

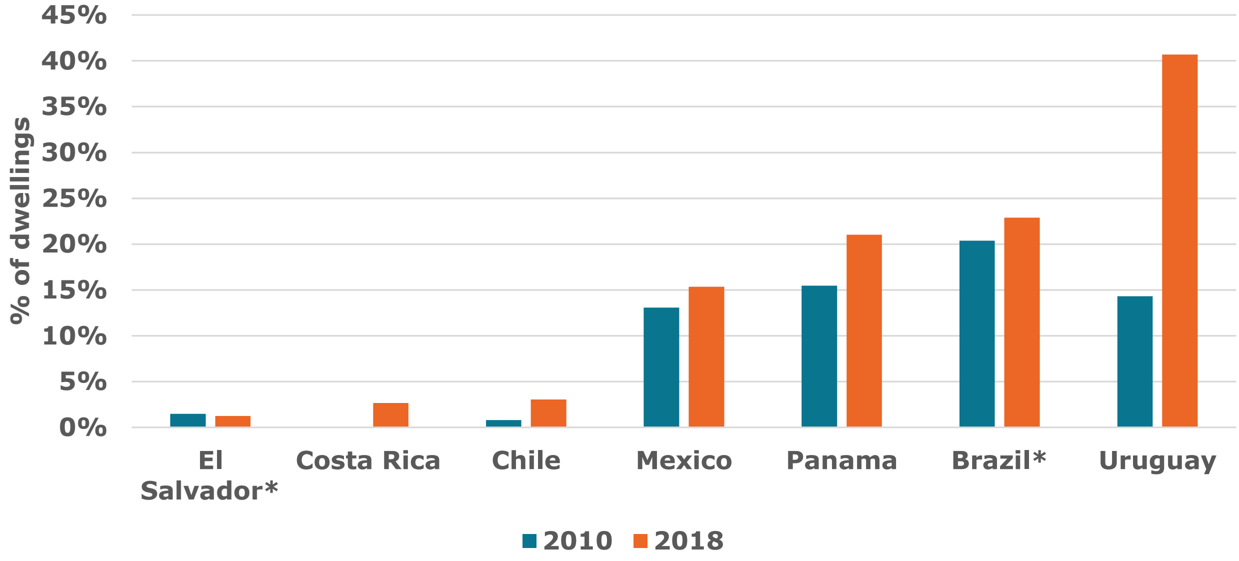
- the increase in the number of households (demographic effect) (see section 4.1);
- the progression in the equipment ownership, as shown for air conditioning (Figure 48) and washing machines and refrigerators (Figure 49) (equipment ownership effect),
- and by energy efficiency improvements, especially in countries with specific policies, mainly on energy efficiency labelling and standards.

The equipment ownership effect will be mainly significant for appliances for which there is a rapid diffusion ; for instance, for air-conditioners in Uruguay (+ 26 points over 2010- 2018) or Panama (+ 6 points) in (Figure 48), or for refrigerators in Panama or washing machines in most countries (Figure 49).

A decomposition of the electricity consumption is illustrated in Box 6 in the case of washing machines, refrigerators and AC in Brazil.

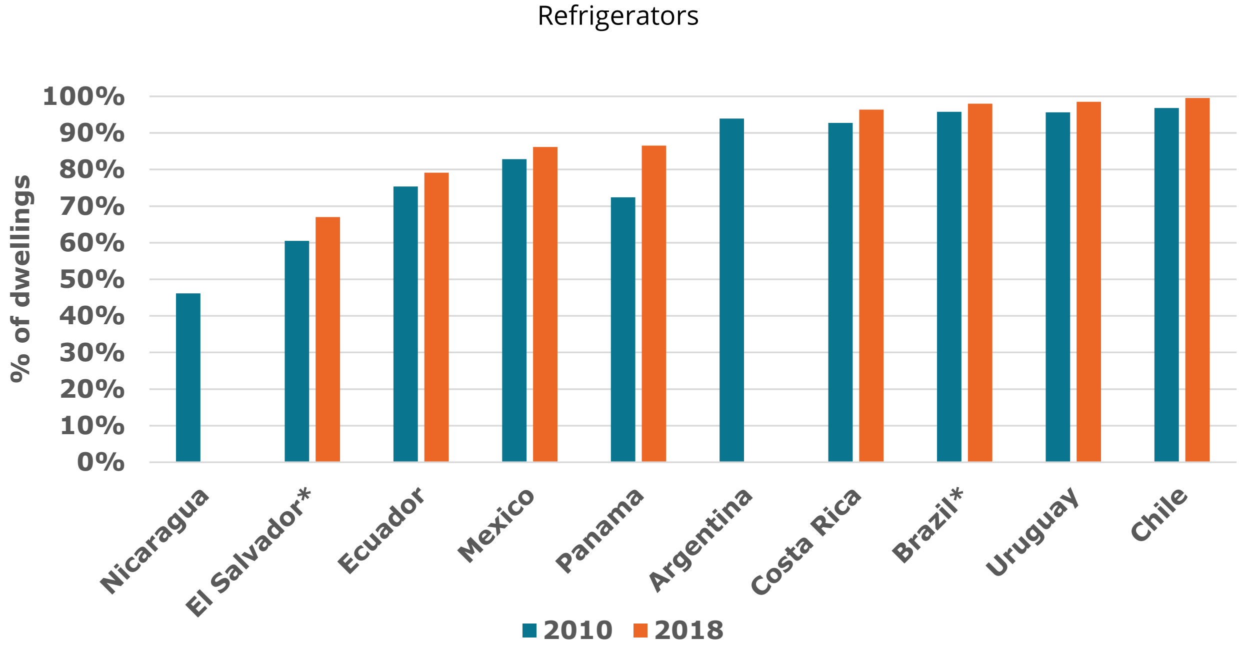
Once energy savings are calculated it is also possible to express them in monetary savings though the so-called financial indicators (see Box 7).

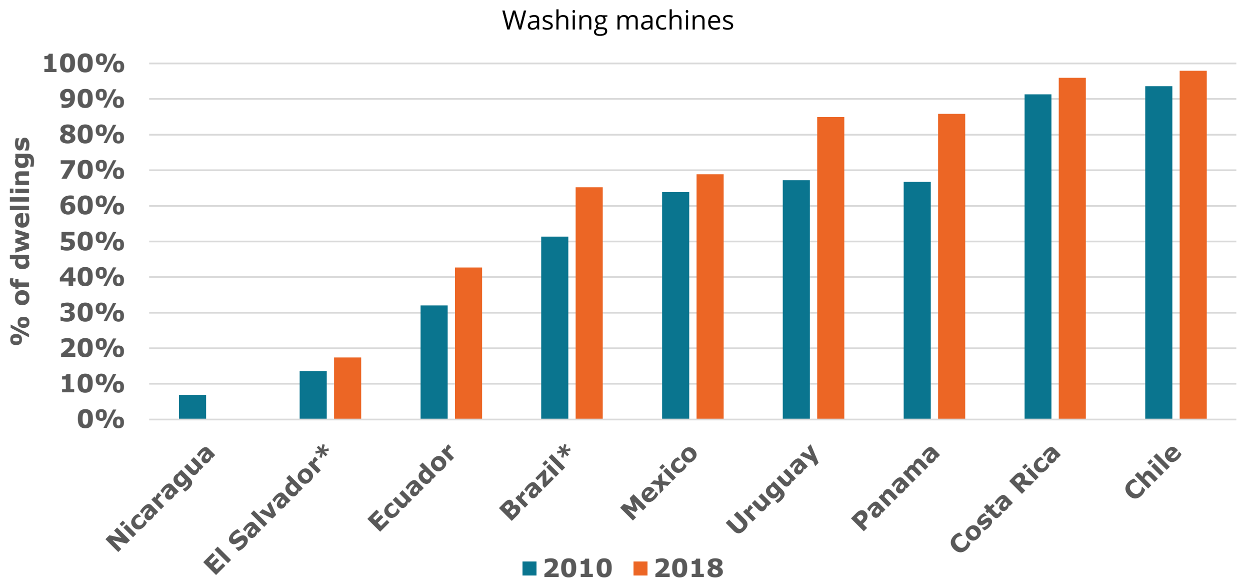
Figure 48: Equipment rate of households with air-conditioners



Source BIEE, Cepal; *El Salvador: 2010-2015; Brazil: 2010-2014

Figure 49: Equipment rate of households in refrigerators and washing machines (%)





Source BIEE, Cepal ; *El Salvador: 2010-2015; Brazil: 2011-2018

Box 6: Understanding electricity consumption variation for large appliances: case of Brazil

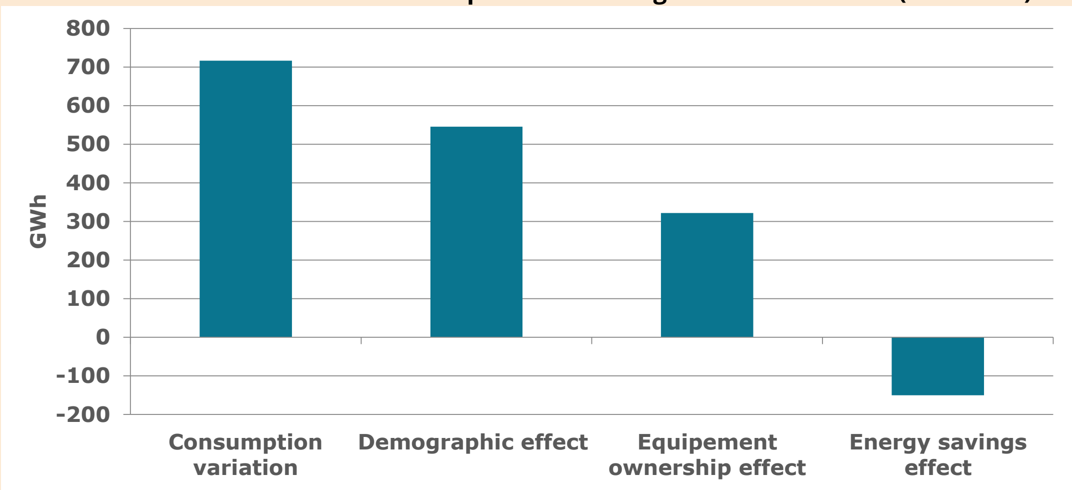
Figure 50 illustrates the drivers behind the variation of the electricity consumption for washing machines in the case of Brazil between 2010 and 2018:

-The increased number of households raised the consumption by 550 GWh ("demographic effect").

-Progression in the diffusion of washing machines contributed to a further 320 GWh increase.

-However, the consumption of washing machines only increased by 720 GWh and not by 870 GWh as energy savings contributed to lower the consumption by 150 GWh.

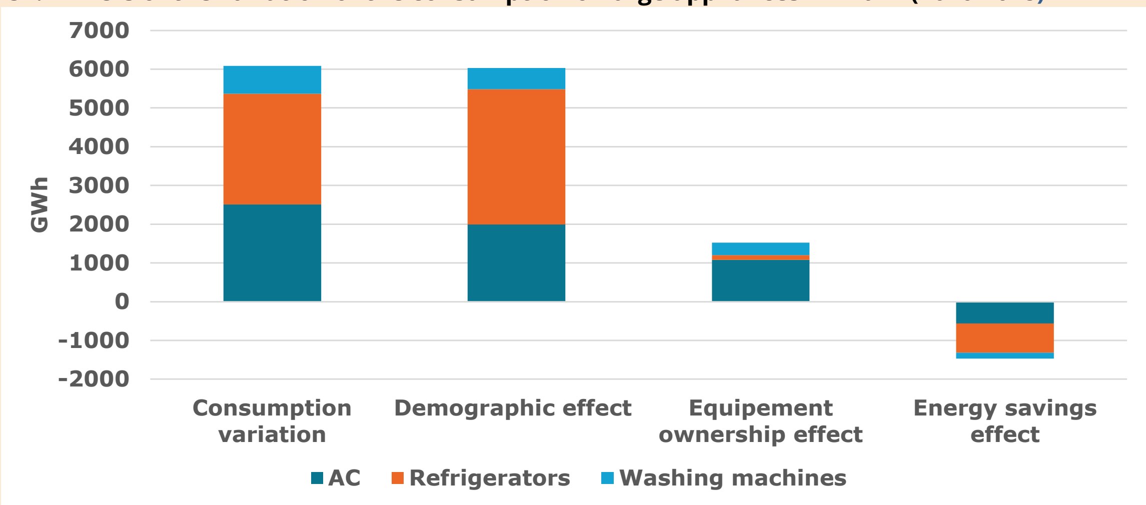
Figure 50: **Drivers of the variation of the consumption of washing machines in Brazil (2010-2018)**[25]



Source: BIEE, Cepal

As all effects are expressed in volumes, the decomposition of the electricity consumption variation for different appliances can be done by aggregating the results for each type of appliances as shown in Figure 51 for AC, refrigerators and washing machines. Energy savings contributed to reduce the total electricity consumption of AC, refrigerators and washing machines by 1.5 TWh.

Figure 51: **Drivers of the variation of the consumption of large appliances in Brazil (2010-2018)**



Source: BIEE, Cepal

[25] The various effects are calculated as follows: demographic $=\Delta HH*TEQ_0*SEC_0$; equipment ownership: $HH_0*\Delta TEQ*SEC_0$ and energy savings: $HH_t*TEQ_t*\Delta SEC$ with Δ: variation over the period, E consumption of appliance, HH: number of households, TEQ: equipment ownership (% of households with appliance) and SEC: specific consumption of appliance (kWh/year).

Box 7: Measuring financial impacts for energy savings: case of Uruguay

The effect of energy savings for households, can be shown in two ways:

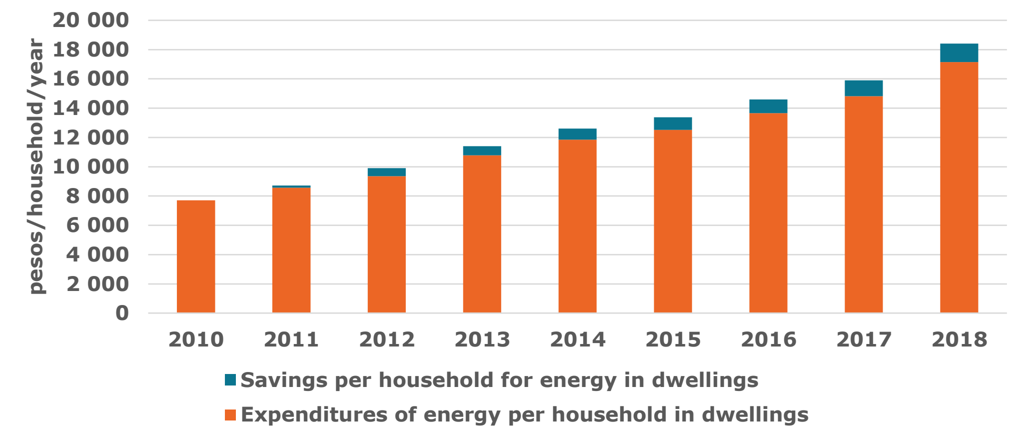
• From the reduction of the energy expenditures i.e. decrease of energy expenditures thanks to energy savings;

• From a reduction of their budget coefficient on energy, i.e. the share of energy expenditures in their total expenditures, what is called the private consumption of households.

The impact of energy savings on the energy expenditures of households is evaluated as the ratio between the actual energy expenditures of households and the theoretical expenditures without energy savings[26].

In Uruguay, the energy savings in dwellings since 2010 led to a decrease of 1 270 pesos in energy expenditures per households in 2018 (17 150 pesos per households out of 18 420 without energy savings) (**Figure** 52). In other words, energy savings in dwellings since 2010 led to an increase in disposable income of around 2 170 pesos per household in 2018.

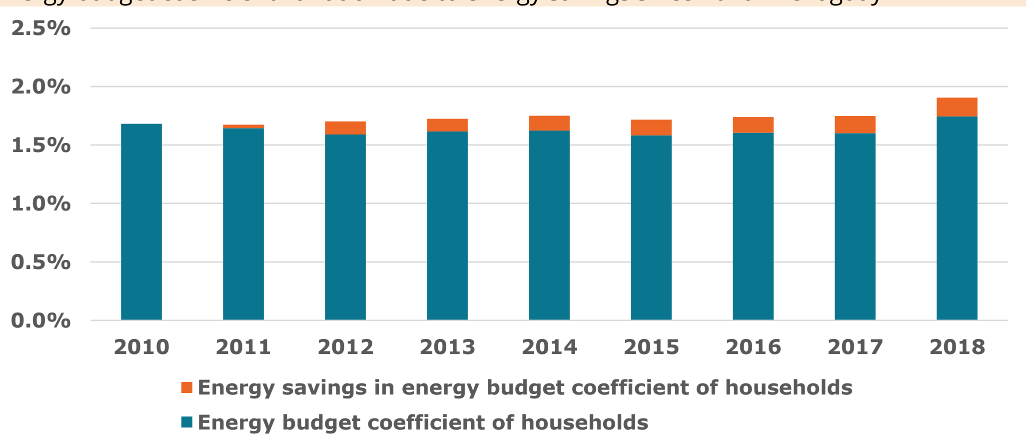
Figure 52**:** Reduction of energy expenditures of households due to energy savings since 2010 in Uruguay



Source: BIEE Cepal

Another financial indicator can be the variation of the energy budget coefficient defined as the difference of the energy budget coefficient with energy and without savings[27]. The energy savings reduced the energy budget coefficient of households (buildings only) by around 0.2 points in 2018 (out of 1.9%) (**Figure** 53).

Figure 53: Energy budget coefficient variation due to energy savings since 2010 in Uruguay



Source: BIEE Cepal

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[26] The savings in energy expenditures per household is calculated by multiplying the energy savings by fuel by the average price of each fuel, divided by the number of households. The energy savings of households in their dwellings are calculated based on the energy efficiency index (EEI) (see methodology in Annex 1). In the case of Uruguay, the EEI is carried out at the level of 4 end-uses: space heating, water heating, cooking and cooling.

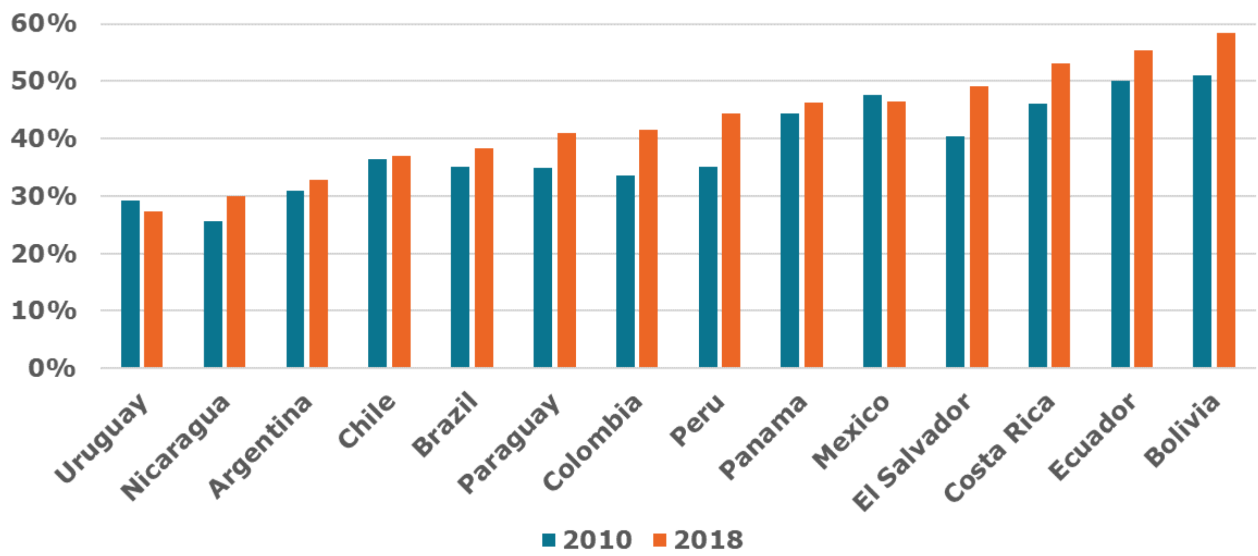
[27] The energy budget coefficient with energy savings is the observed value and calculated as the ratio between energy expenditures of households in their dwellings and private consumption of households. The energy budget coefficient without energy savings is calculated by dividing the energy expenditure without energy savings (i.e. energy expenditures plus monetary savings) by the private consumption of households.

5. Transport

5.1. Trends in consumption

The share of transport sector in final energy consumption ranges from 27% in Uruguay to 58% in Bolivia. This share has increased in most BIEE countries since 2010, except in Uruguay and Mexico.

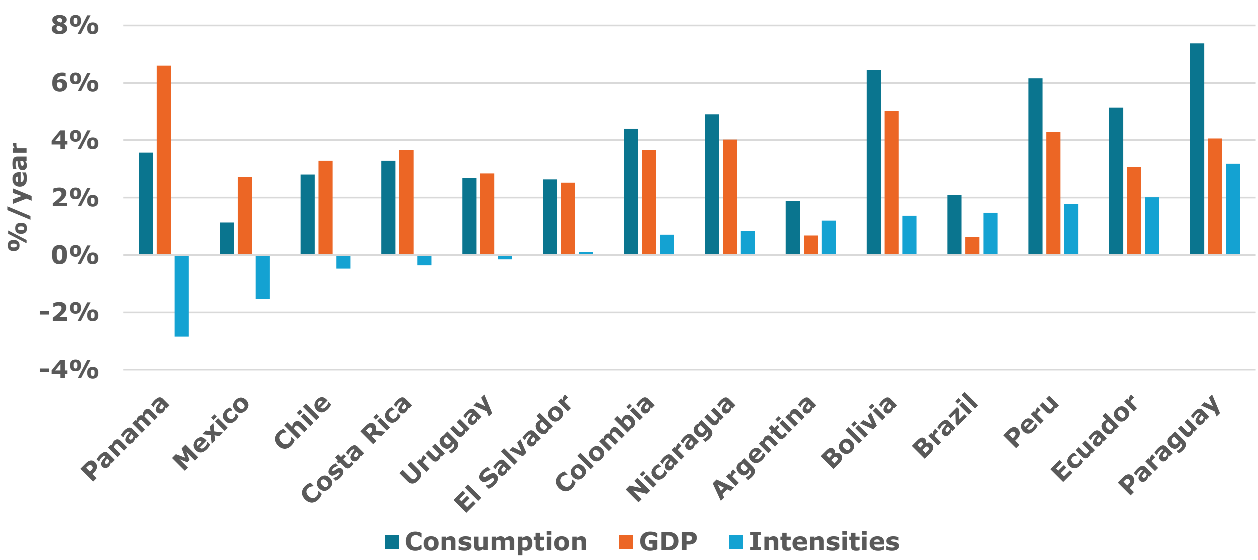
Figure 54: Share of transport in final energy consumption



Source BIEE, Cepal

In two thirds of the countries, transport consumption grew more rapidly than GDP from 2010 to 2018, as shown by the increase in the transport intensity (i.e. energy consumption per unit of GDP) (Figure 55). Increasing trends can be explained by several factors, such as an increasing number of road vehicles, at a faster rate than economic growth, linked to a lack of public transport and the monopoly of road for goods. On the contrary, the energy intensity of transport decreased by 2.8%/year in Panama and 1.5%/year in Mexico. In Mexico, this is explained by the development of public transport in recent years and the energy efficiency standards on light vehicles.

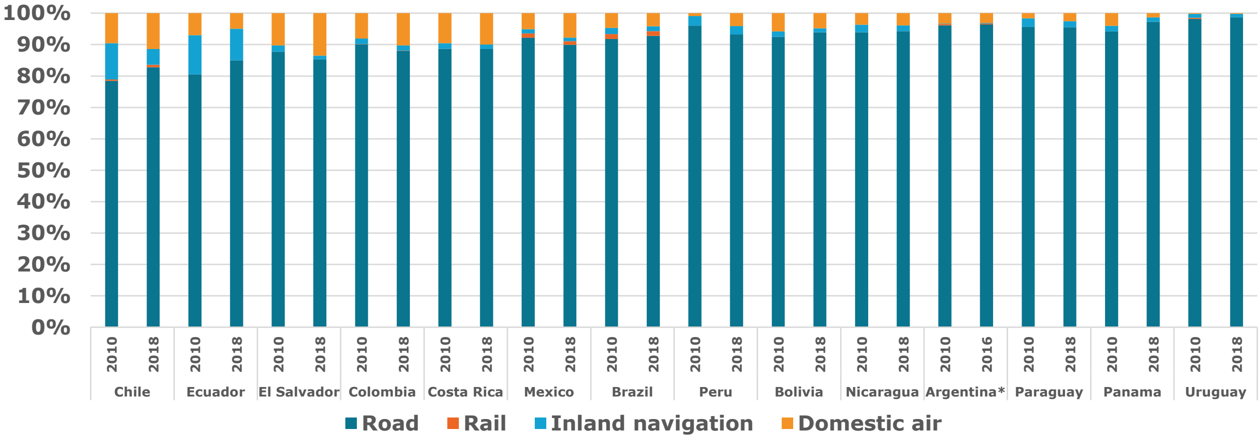
Figure 55: Trends in transport consumption, GDP and transport intensity



Source BIEE, Cepal

Road transport is the main transport mode: it accounts for over 80% of the consumption in all BIEE countries in 2018 (from 83% in Chile to 99% in Uruguay). Overall, the share of road transport remained relatively stable over 2010-2018 except for Chile and Ecuador where it increased by 4 points. In Chile, this trend is explained by the slowdown in inland navigation consumption.

Figure 56: Transport energy consumption by mode



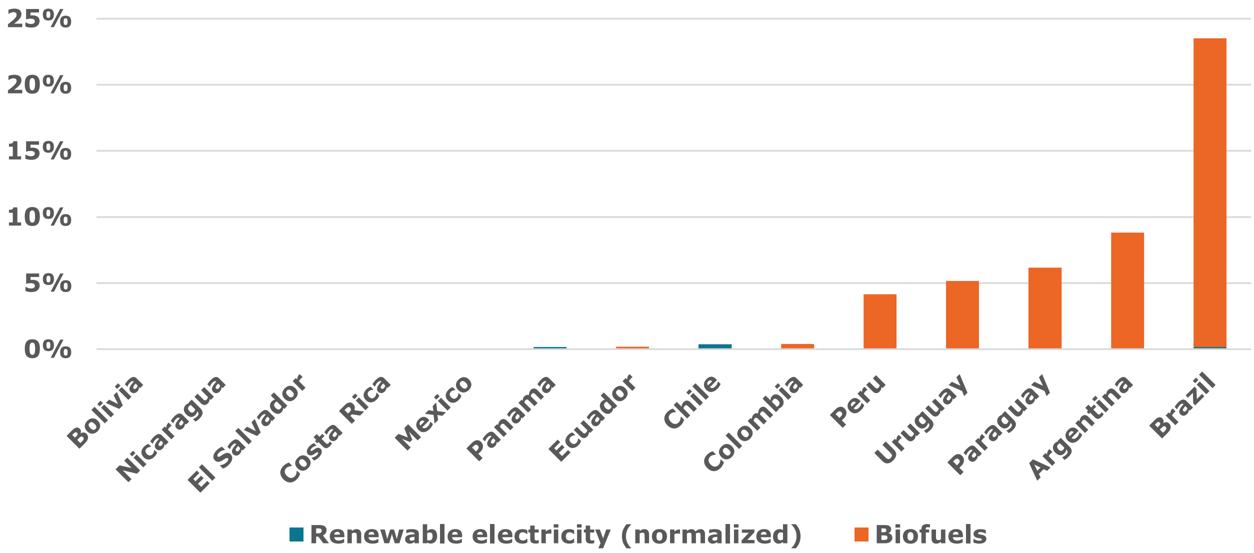
*Argentina: 2010-2016

Source BIEE, Cepal

5.2. Renewables

Brazil has the highest share of renewables in transport consumption (23%) thanks to biofuels. In Argentina, Paraguay and Uruguay, the share of renewables is between 9% and 5%. The use of electricity remains marginal because of limited electrified public transport.

Figure 57: Share of renewables in transport consumption (2018)



Source BIEE, Cepal

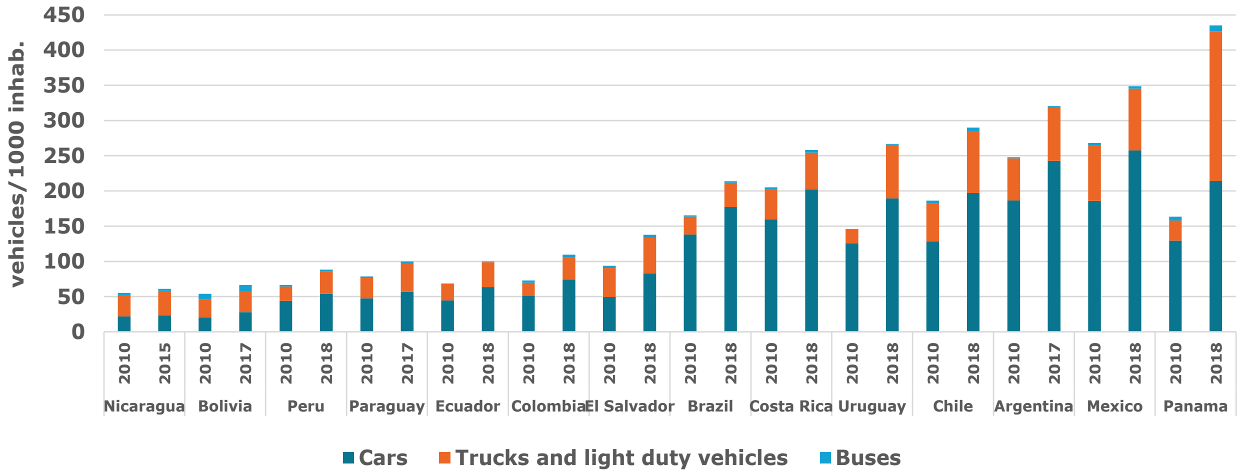
5.3. Road transport

5.3.1. Overview

The energy consumption of road transport has been increasing in all countries since 2010. It grew very rapidly in 5 countries: Paraguay and Bolivia (7%/year), Peru and Ecuador (6%/year) and Nicaragua (5%/year).

The number of road vehicles per capita has increased by more than 3%/year between 2010 and 2018 in most BIEE countries. Uruguay and Panama registered the highest progression (by 8 and 13%/year respectively). The stock of vehicles is made up of cars, buses, light duty vehicles and trucks: cars represent more than one third of this stock in 70% of BIEE countries (Figure 58).

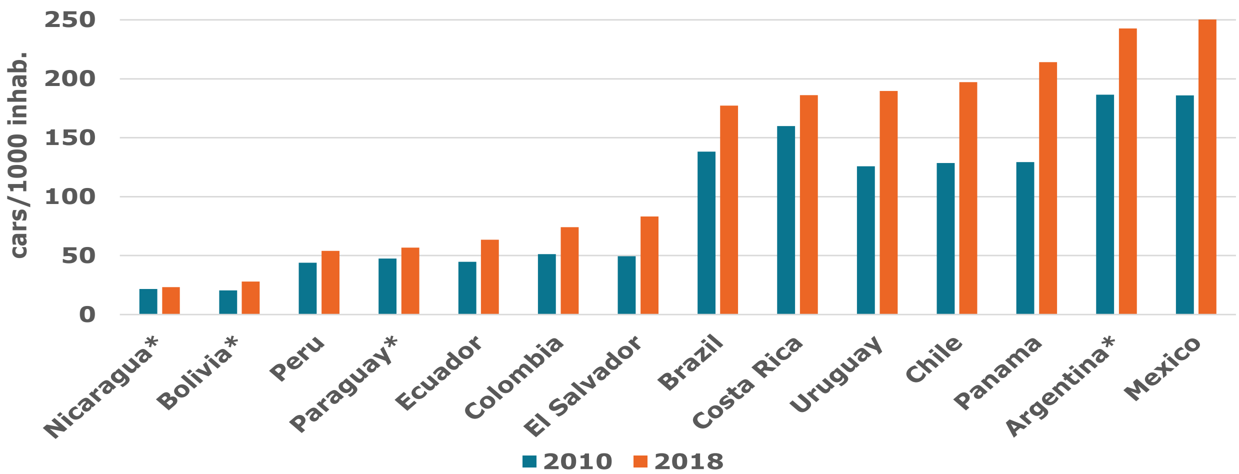
Figure 58: Stock of vehicles per capita



Source BIEE, Cepal

There are significant discrepancies in the level of car ownership among countries, from around 20 cars per 1000 inhabitants in Bolivia to 260 cars per 1000 inhabitants in Mexico in 2018 (Figure 59). The progression in car ownership has been very rapid in El Salvador and Panama (almost 7%/year on average), as well as in Chile, Uruguay and Colombia (around 5%/year).

Figure 59: Number of cars per inhabitant



Source: BIEE, Cepal; *Nicaragua: 2010-2015; Bolivia, Paraguay, Argentina: 2010-2017

5.3.2. Energy efficiency of road transport

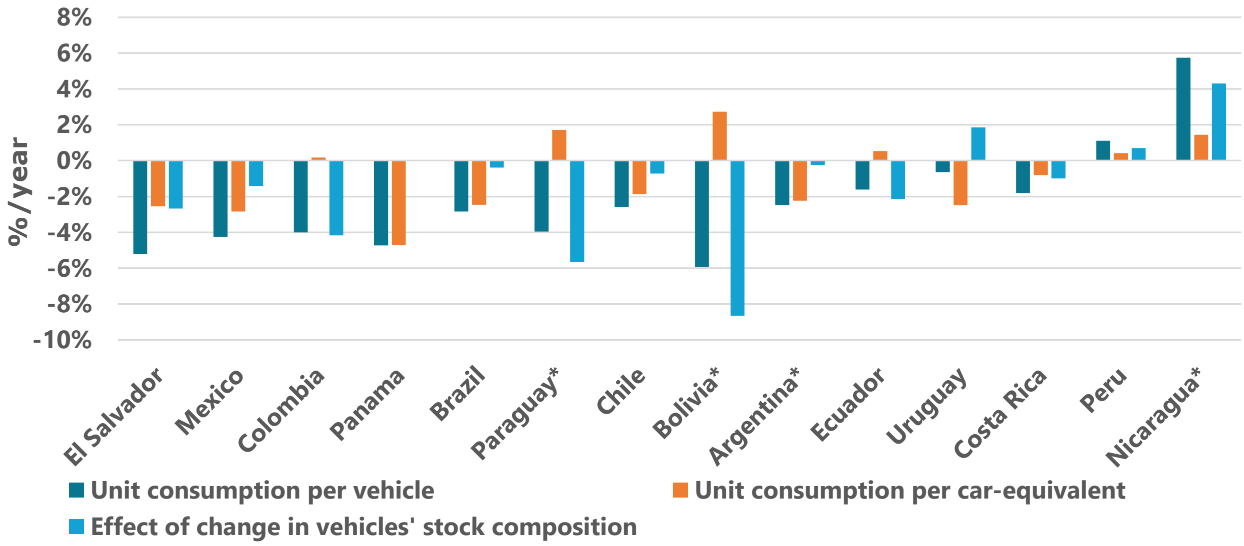
The unit consumption per vehicle has decreased in almost all BIEE countries between 2010 and 2018 (except Peru and Nicaragua). This indictor is influenced by energy efficiency, but also by change in the composition of the stock of vehicles between light and heavy vehicles.

The overall energy efficiency of road transport can be better evaluated by calculating an average energy consumption per car equivalent, as the ratio between the total consumption of road transport and the total fleet of road vehicles expressed in car equivalent[28]. A different variation between the energy consumption of road transport per vehicle and per car equivalent corresponds to the effect of changes in the composition of the vehicle stock. Energy efficiency improvements can be better evaluated with the variation of the unit consumption per car-equivalent, as it is cleaned from changes in the vehicle fleet.

In El Salvador, the consumption of road transport per car equivalent decreased twice less rapidly than the consumption of road transport per vehicle (-2.5%/year compared to -5.2%/year): this is due to a greater share of light vehicles in the stock that contributed to reduce the consumption per vehicle by 2.7%/year. In 70% of BIEE countries, changes in the vehicles' stock composition towards a higher share of light vehicles contributed to lower the consumption per vehicle.

The consumption per car equivalent has decreased by more than 2%/year between 2010 and 2018 in half of BIEE countries, which can be considered as the rate of energy efficiency improvement for road transport for these countries (Figure 60).

Figure 60: Trends in unit consumption of road transport (2010-2018, %/year)



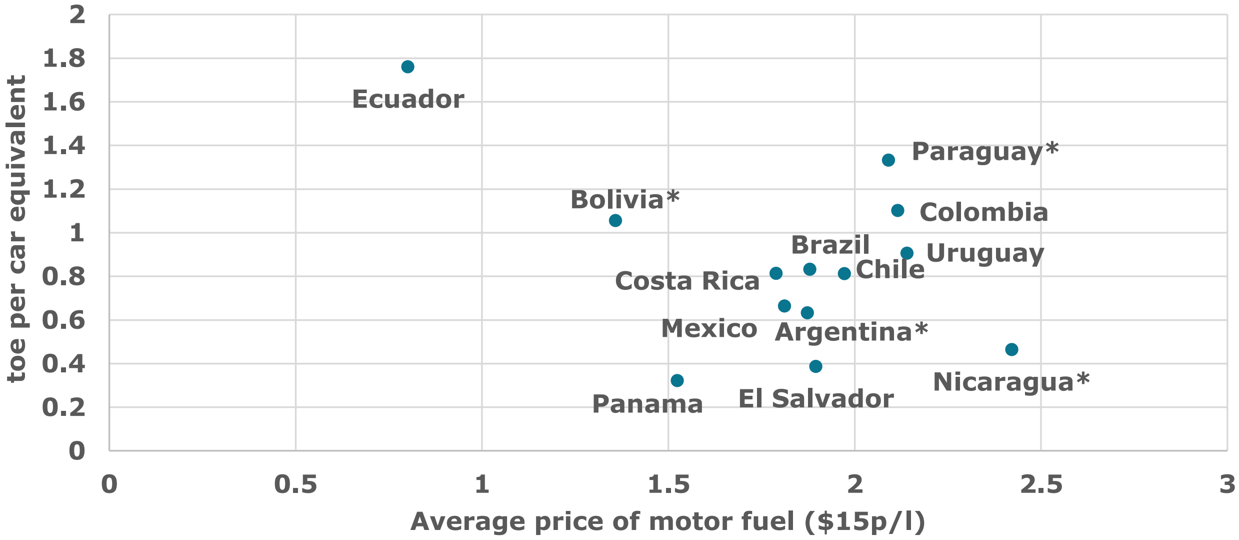
Source BIEE, Cepal; *Nicaragua: 2010-2015; Bolivia, Paraguay, Argentina: 2010-2017

There are discrepancies in the energy consumption of road transport per car equivalent among BIEE countries with similar fuel price, for instance between Brazil, Argentina and El Salvador (Figure 61). It can

[28] For each type of vehicle the stock is measured in terms of equivalent cars on the basis of their specific annual consumption compared to a car. If, for example, a bus consumes on average 15 toe / year and a car 1 toe / year, a bus will be equivalent to 15 cars. For countries with national surveys or data available, national data were used (Mexico, Uruguay, Brazil, Ecuador, El Salvador). For the other countries, the following default values were used: 0.15 car equivalent for two-wheels, 4 for light vehicles and trucks, 15 for a bus.

be due to differences in energy efficiency of vehicles, in their size, as well as to statistical problems in the stock of vehicles actually used[29].

Figure 61: Consumption per car-equivalent and motor fuel prices (2018)



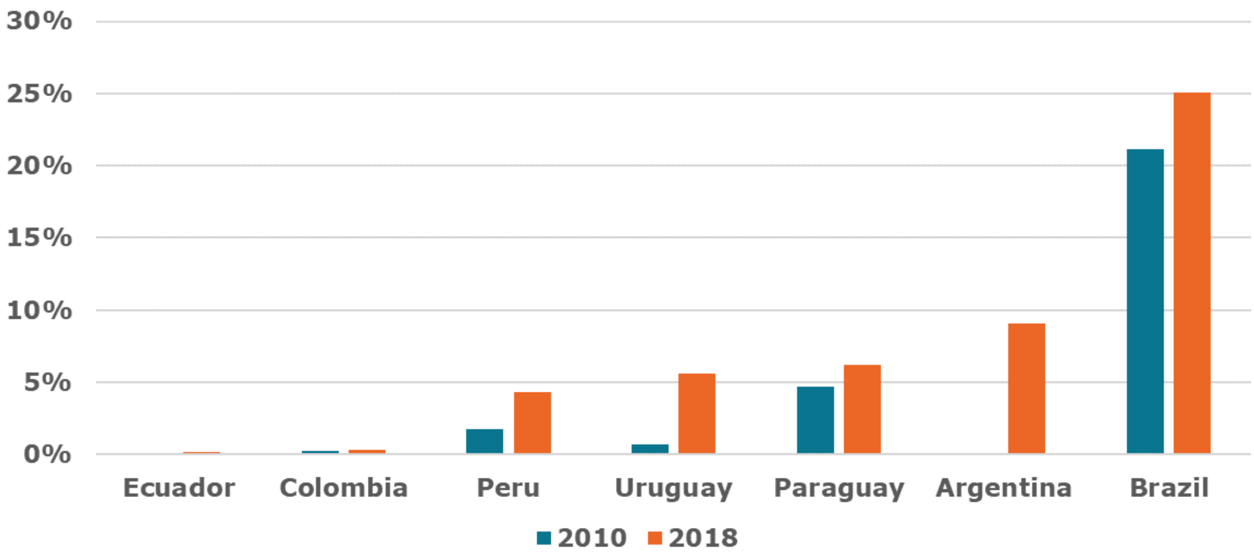
Source BIEE, Cepal; *Nicaragua: 2015; Bolivia, Paraguay, Argentina: 2017

5.3.3. Renewables in road transport

The share of biofuels reached 25% of road energy consumption in Brazil in 2018 (**Figure 62**). It was 9% in Argentina, 6% in Paraguay and Uruguay and 4% in Peru.

Even if biofuels penetration increased strongly in Argentina, Uruguay, Brazil, and Peru (between 3 and 9 points from 2010 to 2018), most of BIEE countries have not yet started developing biofuels.

Figure 62: Share of biofuels in road transport consumption



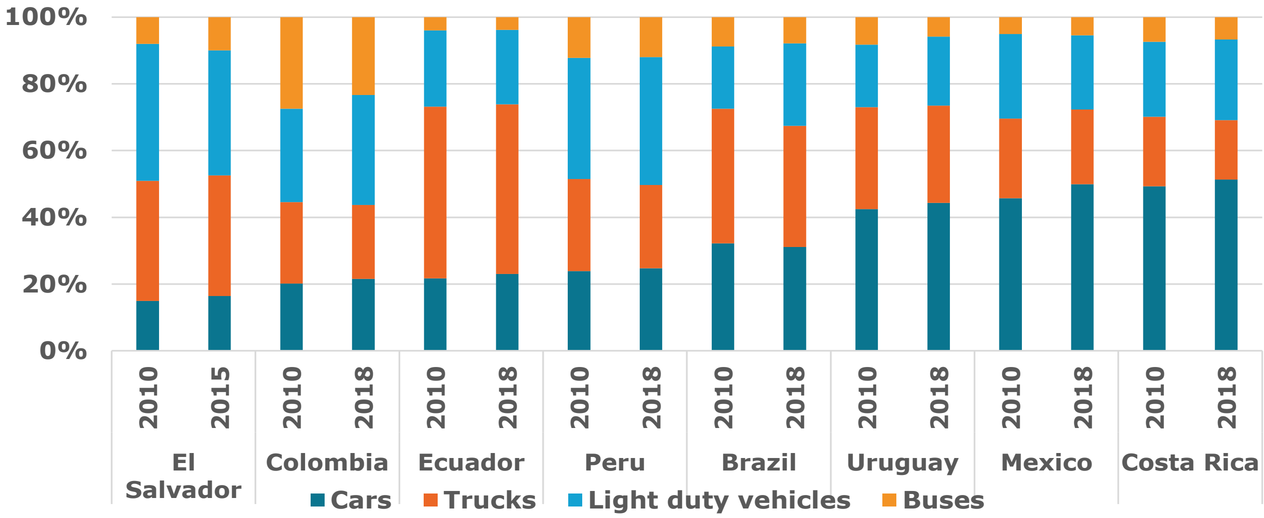
Source BIEE, Cepal

[29] The stock of vehicles is often overestimated as the retired vehicles are not always removed from the national registries.

5.3.4. Cars and trucks

There exist large discrepancies among BIEE countries with data on the breakdown of road consumption by type of vehicles in the share of cars in road consumption: from 16% in El Salvador to 51% Costa Rica in 2018. In Ecuador and Brazil, road consumption is dominated by trucks while in El Salvador, Colombia and Peru, light duty vehicles represent the highest share. Colombia has the highest share of bus in road consumption as people rely strongly on public transport to travel (its car ownership is the lowest among BIEE countries).

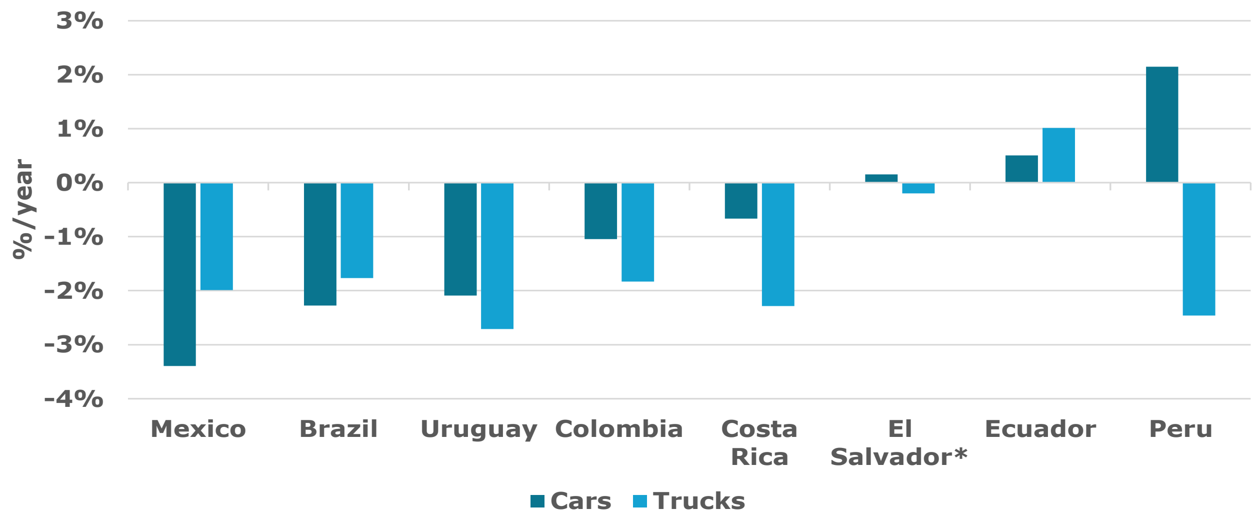
Figure 63: Breakdown of road energy consumption by type of vehicles



Source BIEE, Cepal[30]

The annual energy consumption of cars and trucks (in toe/vehicle/year) gives us a first overview of the energy efficiency of vehicle. The energy consumption per vehicle has mainly decreased in most of BIEE countries with available data. This trend could be explained by technical progress, with the introduction of more efficient new vehicles in the market, but also by the use of smaller vehicles or the decrease in the annual distance travelled (Figure 64). The increase observed in El Salvador (cars), Ecuador and Peru (cars) may be due to an increasing size of vehicles.

Figure 64: Trends in consumption per vehicle, for cars and trucks (2010-2018, %/year)



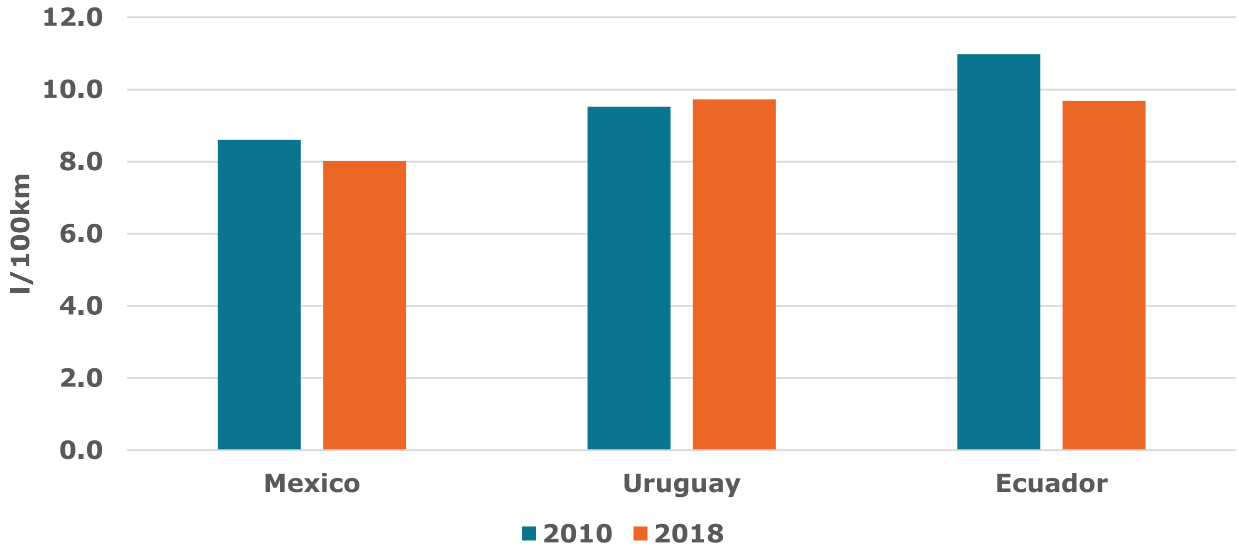
Source BIEE,Cepal

[30] Enerdata estimates based on data provided by national teams from surveys or useful energy balances on equipment ownership and specific consumption (documentation available at https://biee-cepal.enerdata.net)

For cars, the most relevant indicator for measuring energy efficiency progress, especially related to technical progress, is the specific fuel consumption in litres per 100 km or km/l. However, there is a lack of statistical data regarding this indicator in many LAC countries, either for new cars or for the stock average.

In 2018, the specific consumption of cars' stock of BIEE countries with available data ranges between 8 l/100km in Mexico to 9.7 l/100km in Uruguay and Ecuador (compared to 6.9 l/100km at EU level). Between 2010 and 2018, it decreased by 0.9%/year in Mexico and by 1.6%/year in Ecuador. Mexico has introduced Minimum Energy Performance Standards for new cars in 2013 which may explain this performance.

Figure 65: Specific consumption of car stock in l/100km



Source: BIEE Cepal

5.4. Decomposition of transport consumption

For countries with detailed data on traffic and energy consumption by mode, including by transport vehicle, it is possible to explain the role of the different factors behind the variation of the energy consumption over a period. This can be done for the transport consumption as a whole, as well as for passenger transport and goods transports separately, using a methodology of decomposition[31].

For instance, the variation in the consumption of passenger's transport can be explained by 3 main factors:

- **C**hange in total passenger traffic ("**activity** effect");
- Modal shift, i.e. changes in the distribution of each mode in total passengers' traffic ("modal shift");
- Energy savings, measuring the impact of the variation of the specific energy consumption per unit of traffic (passenger- kilometre) for each mode of transport.

An example of application of this methodology is given in Box 8 for Mexico.

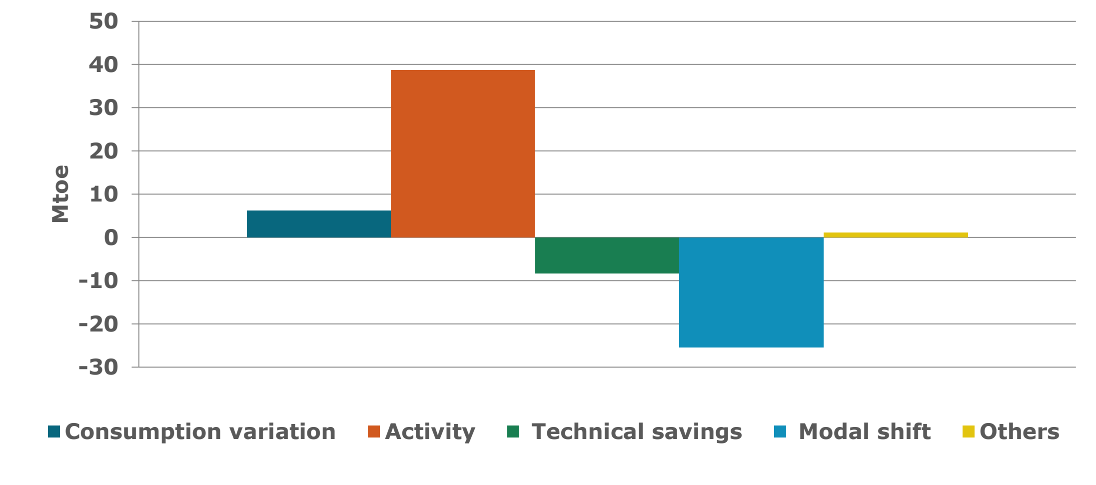
[31] See more detailed on the decomposition methodology in the documentation section at https://biee-cepal.enerdata.net

Box 8: Decomposition of the consumption variation in transport: case of passenger

Between 2010 and 2018, the increase by 6 Mtoe of passengers consumption in Mexico was the result of three main drivers:

- A growth in passenger traffic, which would have increased consumption by 39 Mtoe;
- Energy savings (8 Mtoe), due to lower unit consumption of road vehicles (measured in toe per passenger-kilometre) and planes (toe per passenger), that limited the consumption increase.
- Modal shift (24 Mtoe), due to a higher share of buses in total passengers' traffic (high development of public transport in recent years).

Figure 66: Decomposition of the passengers transport consumption: case of Mexico (2010-2018)[32]



Source BIEE, Cepal

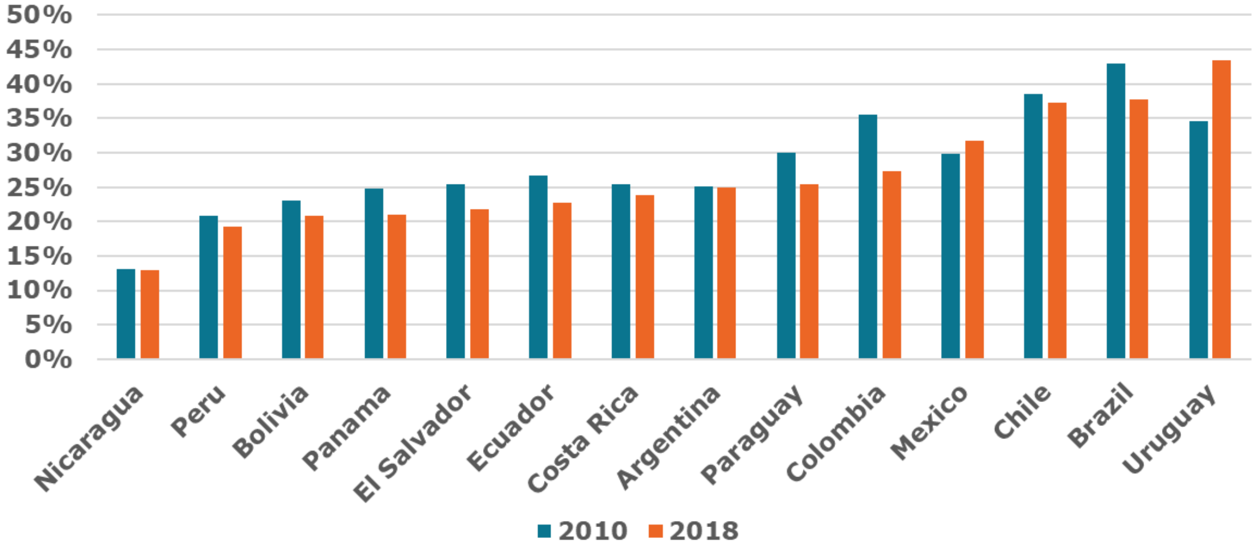
[32] More information can be found on decomposition methods applied to Mexico at http://www.biee-conuee.enerdata.net

6. Industry

6.1. Energy consumption patterns

For most countries, the share of industry in the final energy consumption is declining. It increased significantly in Uruguay (+9 points) because of the commissioning of a new pulp mill in 2014 that contributed to increase the energy consumption of the sector by 70% between 2010 and 2018 (Figure 67). The contribution of industry is the highest in Brazil (38%) and Uruguay (43%) and the lowest in Nicaragua (13%), where this sector is traditionally less developed.

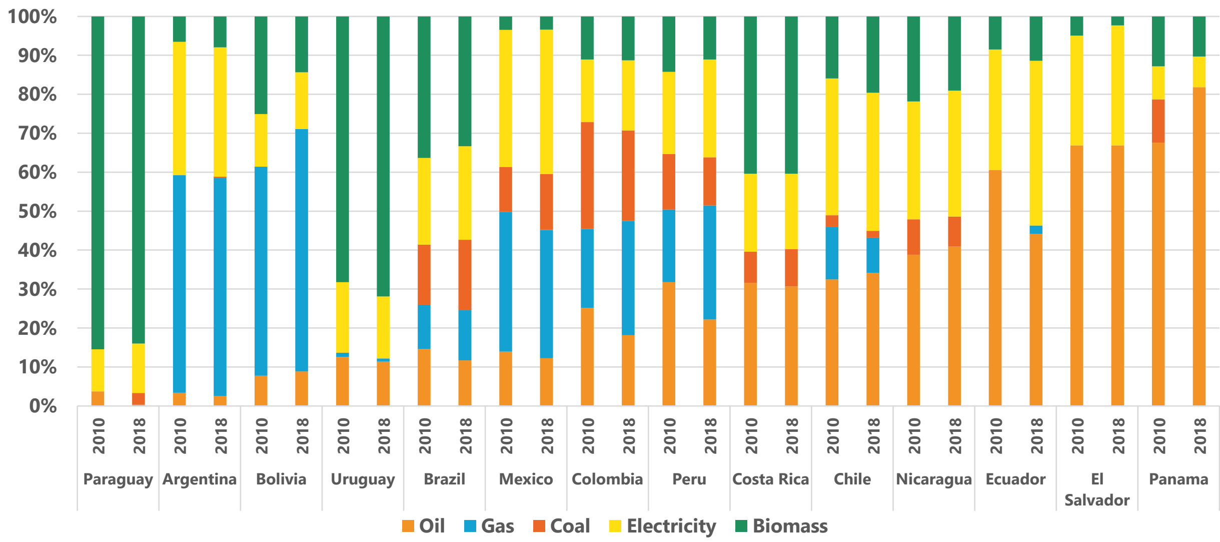
Figure 67: Share of industry in the final energy consumption



Source BIEE, Cepal

The energy mix in industry varies strongly between countries: this is mainly due to differences in industry specialisation, i.e. the distribution of consumption by industrial branch. Oil dominates the energy consumption of industry in Panama (82%) and El Salvador (67%). Biomass is the main energy source in industry in Paraguay (84%), Uruguay (72%). Gas is important in Bolivia (62%) and Argentina (56%). Electricity has a high market share in Chile, Mexico and Ecuador (above 35%).

Figure 68: Energy consumption of industry by energy source



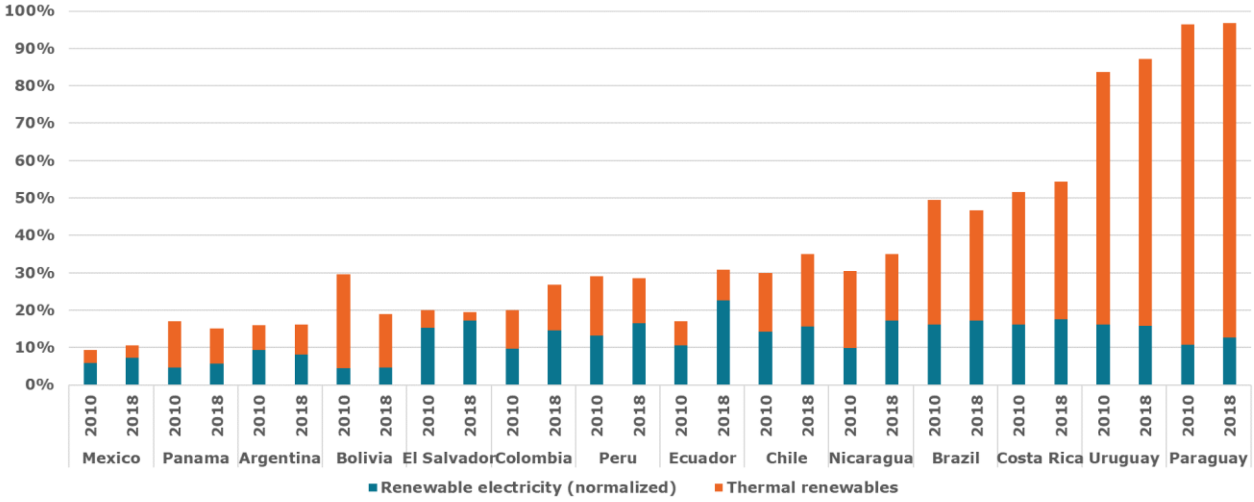
Source BIEE, Cepal

6.2. Renewables

Paraguay and Uruguay lead the way, with more than 85% of industry's final consumption coming from renewable sources in 2018 (mainly biomass, but also renewable electricity) (Figure 69). The share of renewable electricity exceeds 15% in 9 countries and is the highest in Ecuador (23%).

The highest progression for biomass is observed in Chile and Uruguay (+4 points), while the highest increase for the share of renewable electricity took place in Ecuador (+12 points), followed by Colombia and Nicaragua (respectively +5 and +7 points).

Figure 69: Share of renewables in industry sector



Source: BIEE, Cepal

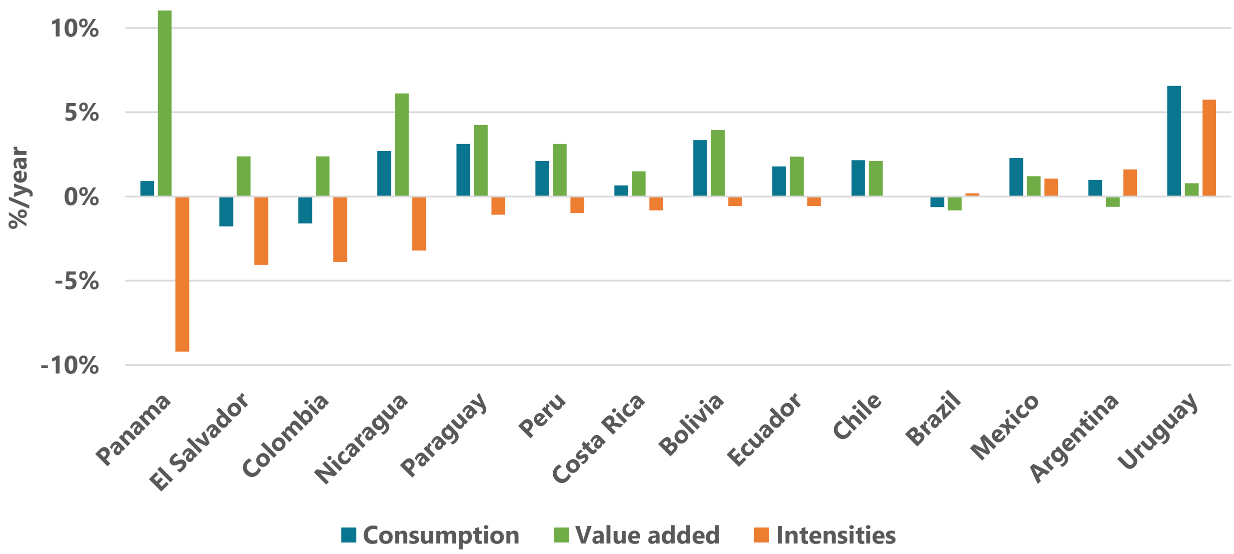
6.3. Overall energy efficiency trends

The energy intensity of industry, calculated as the ratio between the energy consumption and the value added, decreased rapidly between 2010 and 2018 in Panama (9%/year), in El Salvador and Colombia (around 4%/year) and in Nicaragua (3%/year). In five other countries, the energy intensity has been also decreasing, but less rapidly (below 1%/year) (
Figure 70). This decreasing trend can reflect energy efficiency improvement but also a growing share of less intensive industrial branches (i.e. structural changes)[33].

Uruguay is an exception with a sharp increase in the intensity by 5.7%/year over 2010-2018, due to the commissioning of a new large pulp and paper factory in 2014. Brazil, Argentina and Mexico also registered an increase in their intensity.

[33] Energy intensive branches refer to industrial branches that consume a high amount of energy to produce one tonne of product or 1$ of VA (e.g cement, steel, chemicals and paper industries).

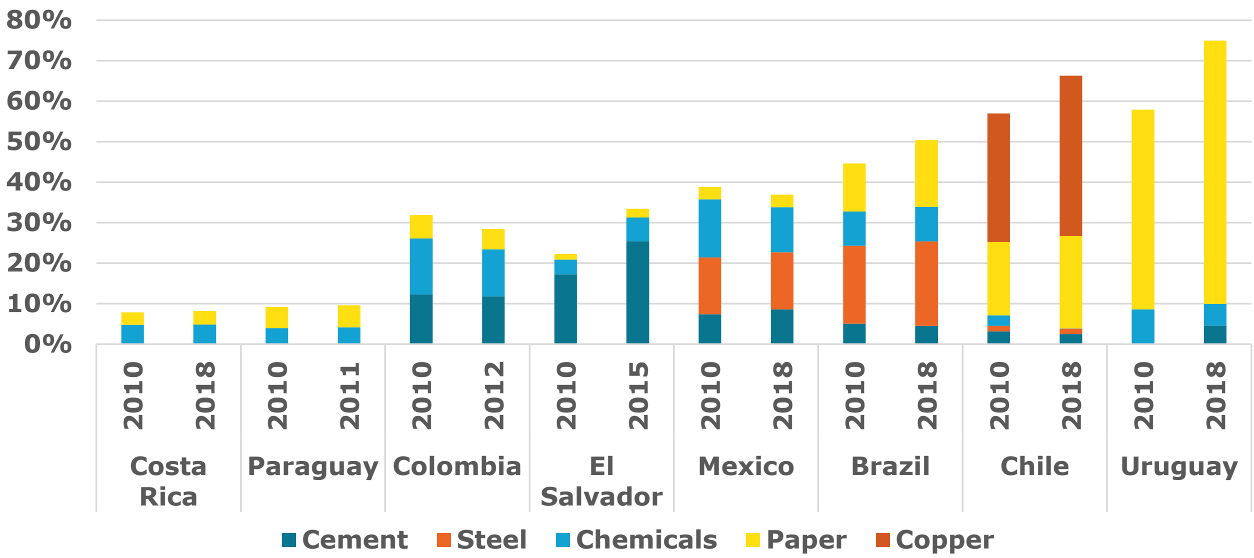
Figure 70: Energy intensity trends in industry (2010-2018)



Source: BIEE, Cepal

The share of energy intensive branches in industry consumption is the highest in Uruguay (75% in 2018), followed by Chile (66%), Brazil (58%) and Mexico (50%) (Figure 71). In Uruguay, paper industry represented 65% of the final energy consumption of industry in 2018 while in Chile, copper industry dominated consumption (40%).

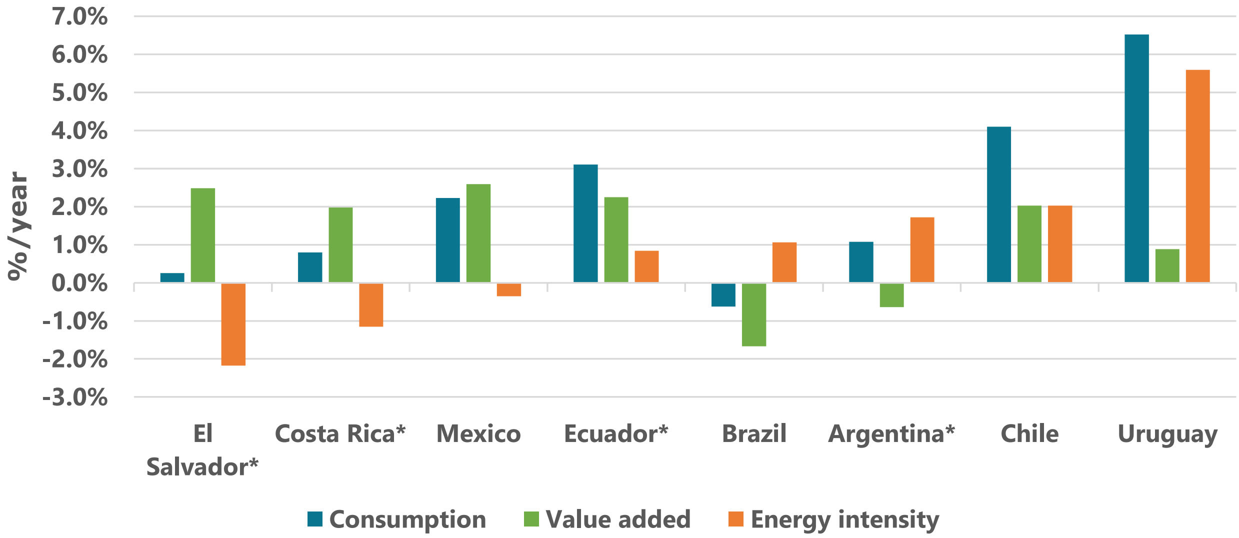
Figure 71: Energy intensive branches in industry



Source BIEE, Cepal

Manufacturing industry[34] represents the bulk of the consumption of industry, except in countries with a large mining sector (e.g. Chile). The trend in energy intensity of manufacturing has been decreasing in El Salvador (-2.2%/year over 2010-2015), Costa Rica (-1.2%/year over 2010-2014) and Mexico (-0.4%/year over 2010-2018) (Figure 72). It particularly increased in Uruguay from 2010 to 2018, by 5.6%/year on average, due to the important rise in consumption (6.5%/year) compared to the value added (0.9%/year). Overall, the variations observed for the total industry are smoother than for manufacturing because of the construction sector, which has a significant weight in the industrial value added but a low energy consumption.

Figure 72: Trends in manufacturing industries (2010-2018)

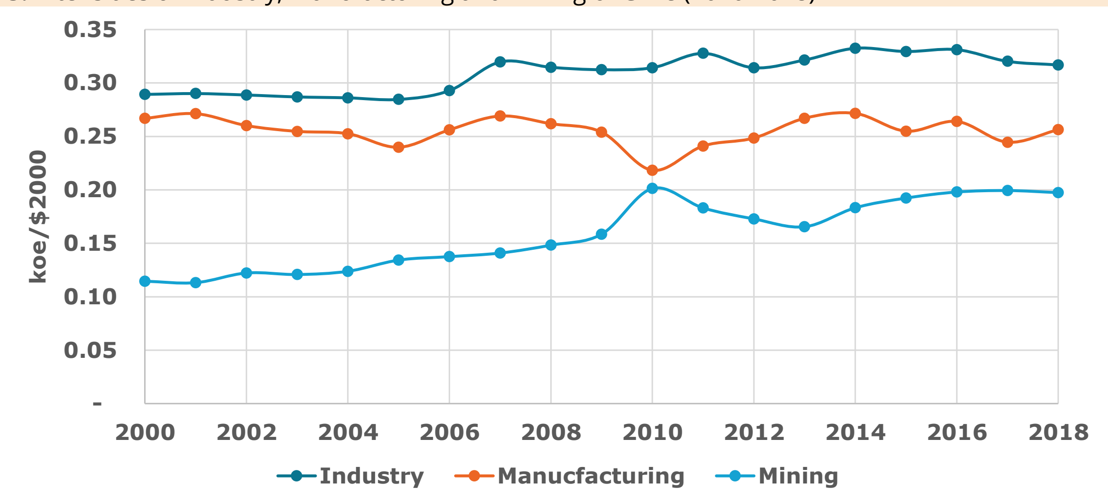


Source BIEE, Cepal ; *Costa Rica: 2010-2014. El Salvador, Ecuador: 2010-2015. Argentina: 2010-2016.

Box 9: Different trends between manufacturing and industry intensities: case of Chile

In Chile, the mining sector represented 47% of industry consumption in 2018. Industry intensity increased by 0.5%/year on average over 2000-2018 while the intensity of manufacturing industry decreased by 0.2%/year. This is explained by the sharp increase in mining industry intensity (by 3.1%/year), as mining extraction process became more and more energy intensive.

Figure 73**:** Intensities of industry, manufacturing and mining of Chile (2010-2018)

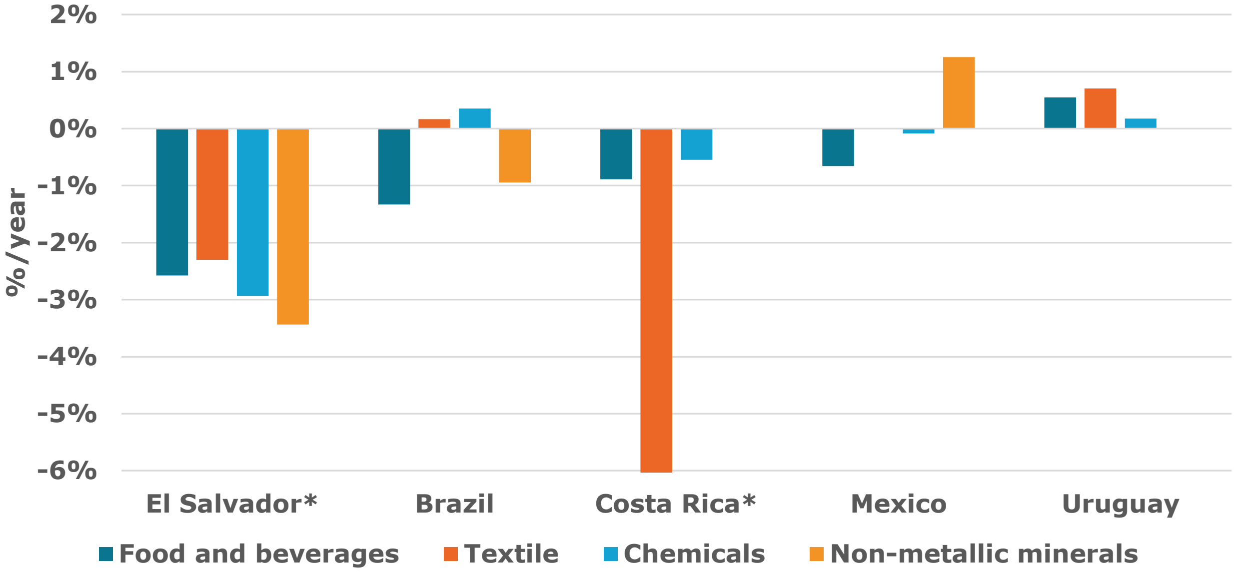


Source: BIEE Cepal

[34] Manufacturing represents the main part of the energy consumption and valued added of industry. The other main sub-sectors are mining and construction.

There are strong disparities in the energy intensity trends by branch (Figure 74). The sectoral intensity of food and beverages has decreased for all countries except Uruguay, while for the other branches, the trend depends on the country.

Figure 74: Energy intensities by branch (%/year, 2010-2018)



Source BIEE, Cepal; *El Salvador: 2010-2015; Costa Rica: 2010-2014

The variations in these sectoral intensities reflect the impact of technical progress, of energy efficiency policies and measures implemented, as well as changes in the types of products produced (some kind of structural changes within each branch[35]).

6.4. Impact of structural changes in manufacturing

Trends in the energy intensity of manufacturing industry are influenced by changes in sectoral intensities (i.e. intensities of the various branches, such as chemicals, minerals non-metallic, food processing, textiles, etc.), but also by changes in the structure of value added by branch ("structural changes"), i.e. changes in the contribution of each branch in the value added of manufacturing.

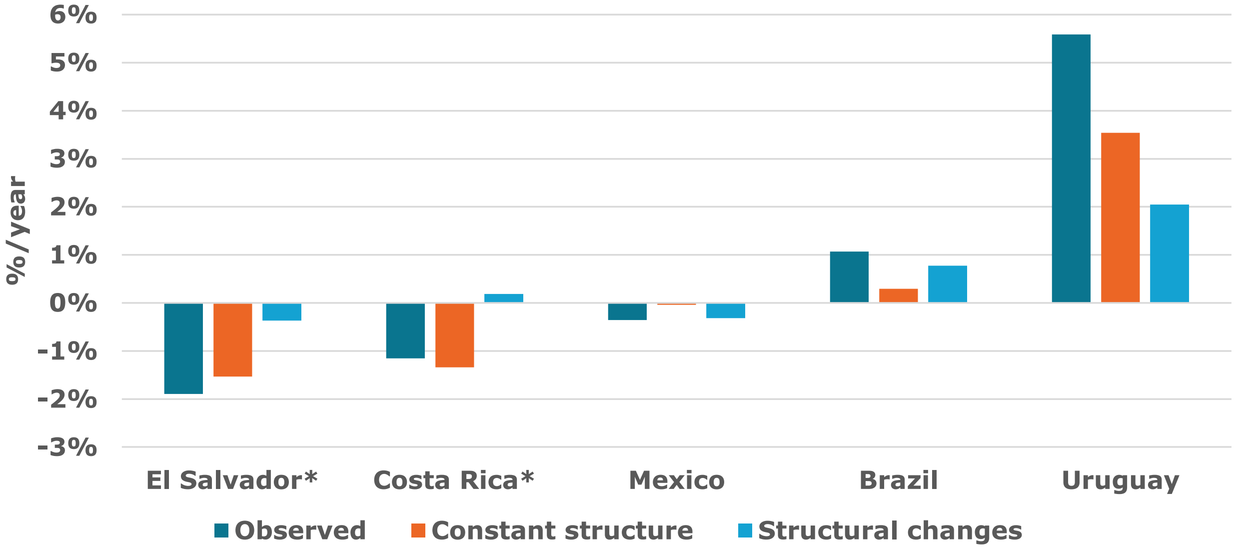
In countries with an increasing share of energy intensive branches in the value added, the energy intensity increases, all things being equal. On the opposite, a greater specialization towards less intensive branches, such as textiles or electrical equipment, reduces the energy intensity.

To separate the impact of these two factors, an intensity of manufacturing can be calculated at constant structure; it represents a theoretical intensity that would have been observed if the structure of the value added between the different branches had remained constant. The variation of the intensity at constant structure better reflects energy efficiency progress. The different trends in the two intensities (actual and at constant) structure measure the effect of structural changes.

[35] For instance an increasing share of deep frozen products in food industry will increase the energy intensity, all things being equal.

In Brazil and Uruguay, structural changes contributed to the energy intensity increase between 2010 and 2018, because of a growing contribution of energy intensive branches. In other BIEE countries with available data, structural changes had a marginal effect on energy intensity trends (Figure 75).

Figure 75: Structural effect in manufacturing industry (2010-2018)



Source : BIEE Cepal

The impact of structural changes can also be shown to explain the variation of the consumption of industry over a period, through a decomposition analysis.

The industrial energy consumption is changing under the influence of various factors:

- Change in industrial activity, measured the Industrial Production Index (IPI) ("**activity effect**");
- Structural changes, i.e. the fact that individual branches with different energy intensities are not growing at the same rate ("**structural effect**"), as explained above in section 6.3;
- **Unit consumption effect** (i.e. change in the ratio energy consumption per IPI or physical production (e.g. for pulp and paper industry) at branch level). A negative effect represents energy savings.

An illustration of such a decomposition is shown in Box 10 in the case of Uruguay.

Box 10: Decomposition of the energy consumption of industry: case of Uruguay

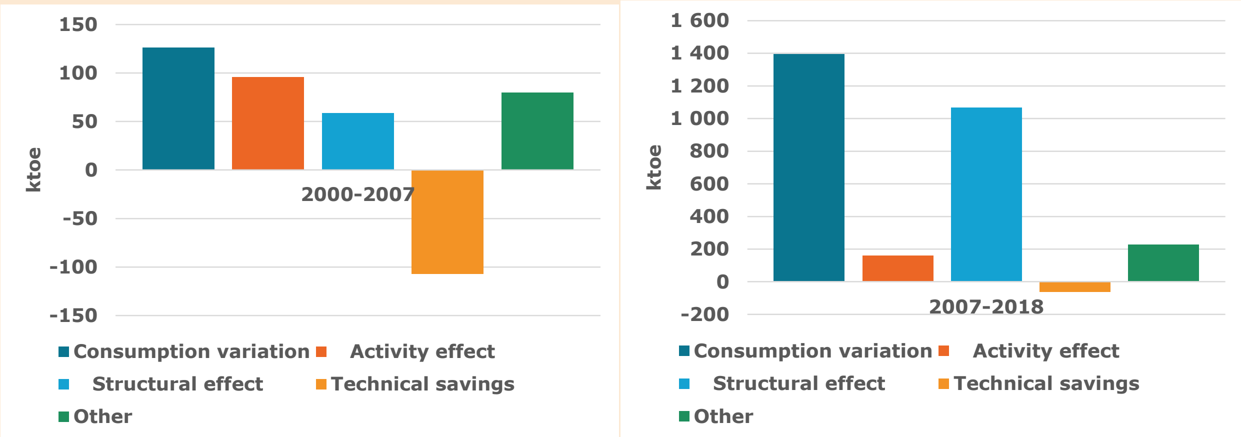
In Uruguay, the increase of the industrial energy consumption by around 130 ktoe between 2000 and 2007, was the result of opposite effects:

-On the on hand, the increase in industrial production and structural changes towards more intensive industries contributed to increase the consumption by 100 and 60 ktoe respectively

-On the other hand, energy savings contributed to lower the consumption by 30 ktoe (100 ktoe of technical savings[36] which have been partially balanced by negative savings).

Over 2007-2018, the decomposition gives very different results: the sharp increase in energy consumption by 1.4 Mtoe was mainly due to the structural changes. Indeed, the share of pulp and paper industry in total industrial production increased strongly due to the commissioning of two new large pulp and paper plants in 2008 and 2014. This contributed to increase the consumption by 1.1 Mtoe.

Figure 76: Decomposition of the variation of industrial consumption in Uruguay



Source BIEE, Cepal

6.5. Specific consumption of energy intensive industries

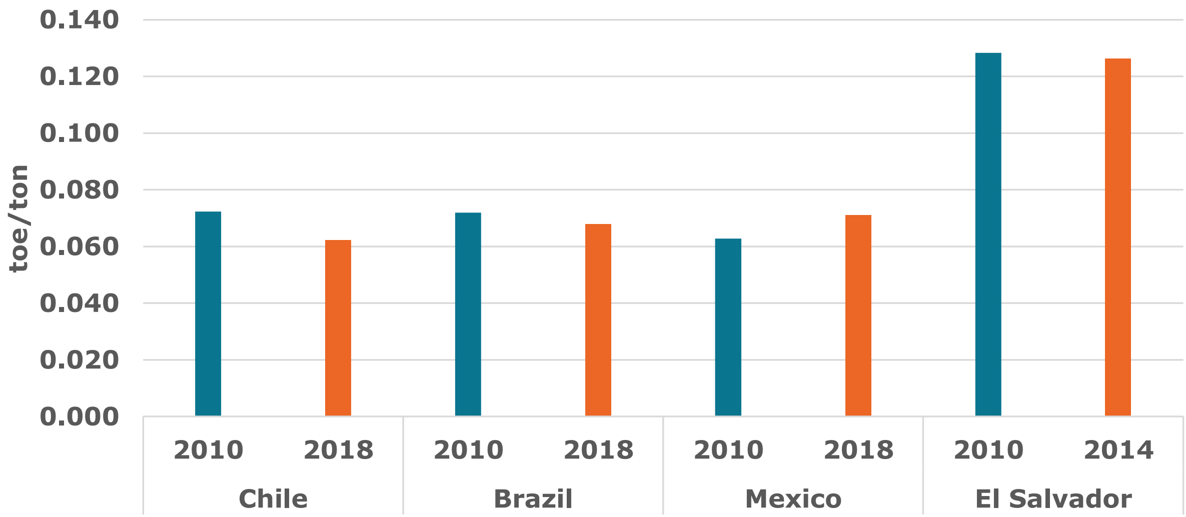
6.5.1. Cement

Trends in the specific consumption per ton of cement are shown in Figure 77 for four countries. El Salvador has one of the highest specific consumption (0.13 toe/ton in 2014), It is around 0.06-0.7 toe/ton in Chile, Brazil and Mexico, which is comparable to the EU average.

Between 2010 and 2018, the specific consumption of cement decreased for Brazil and Chile (-0.7 and -1.9 %/year respectively), reflecting an improvement in the energy efficiency of the sector. Conversely, it increased significantly in Mexico (+1.6%/year).

[36] Technical savings are corrected to account for the fact that technical efficiency cannot get worse : they are equal to the gross savings (based on the observed variation of specific or unit consumption) minus the negative savings; in other words they do not take into account the negative savings.

Figure 77: Trends in specific consumption of cement industry



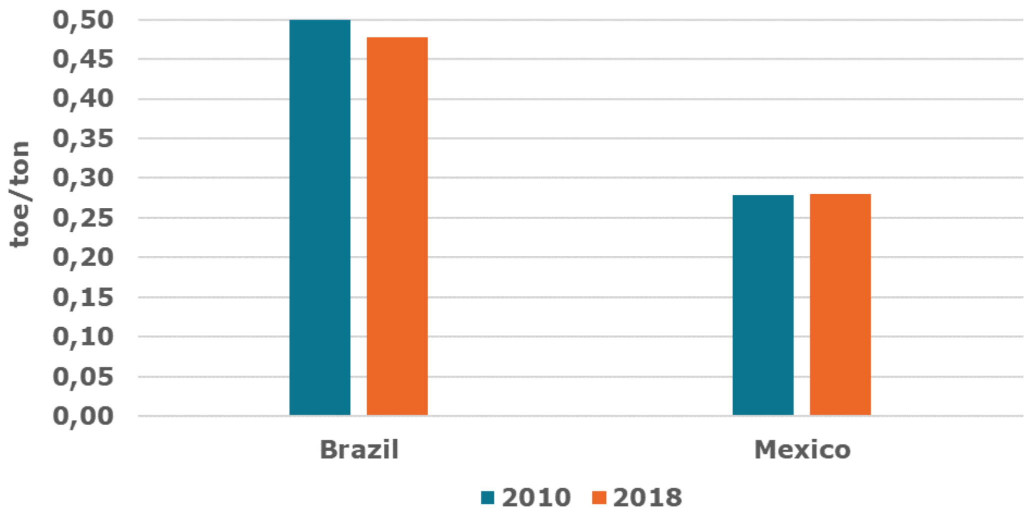
Source BIEE, Cepal

6.5.2. Steel

The specific consumption of steel, calculated as the energy consumption of steel industry per ton of steel produced, depends on the share of each process (electric versus oxygen process) and on the energy efficiency performance of the steel factories. The electric process consumes on average 3 times less energy than the oxygen process. Specific consumption of steel is about twice as high in Brazil as in Mexico, because in Brazil only 25% of steel is produced in electric furnaces, compared to almost 80% in Mexico.

After a decrease in specific consumption of steel between 2000 and 2010 reflecting energy efficiency improvements, and in the case of Mexico, an increasing share of the electric process (+4 points), Mexico's specific consumption is stabilizing. Improvement continued in Brazil (-0.6%/year between 2010 and 2018). (Figure 78).

Figure 78: Trends in specific consumption of steel industry



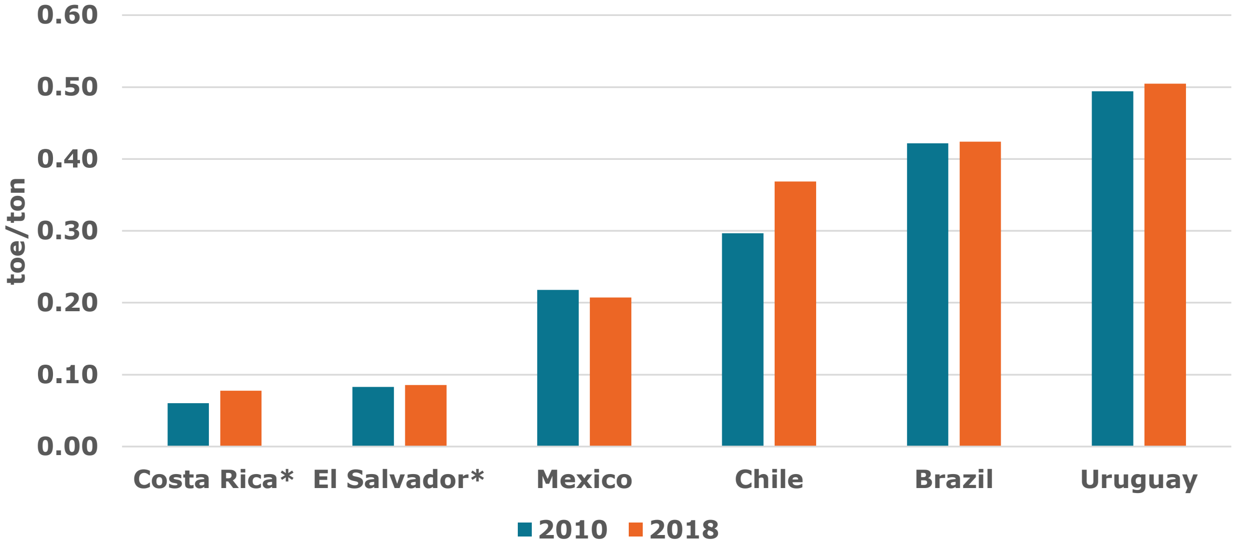
Source BIEE, Cepal

6.5.3. Pulp and paper industry

The specific consumption of pulp and paper, calculated as the energy consumption of paper industry per ton of pulp and paper produced, is an indicator of the energy efficiency of the sector. Its value depends on whether the country is producing pulp. Specific consumption of paper in Mexico (0.21 toe/ton) is close to the EU average, while that of Brazil and Uruguay are about twice as high, because of a higher production of pulp, the most energy intensive part of the production.

Between 2010 and 2018, Mexico decreased its specific consumption of paper (-0.6%/year), mainly because of reduction in the pulp production which dropped from 15% of paper production in 2000 to 2% in 2018. On the contrary, specific consumption of paper increased in Chile, Brazil and Uruguay, with a progression of the share of pulp in paper production (a doubling in Brazil, between 2000 and 2018).

Figure 79 : Trends in specific consumption of pulp and paper industry



Source: BIEE Cepal ; *Costa Rica: 2014, 2018 ; El Salvador: 2010, 2015

Combining the trends observed in the specific consumption of energy intensive branches, as shown above, and for the other branches it is possible to assess the overall energy efficiency progress in industry with an Energy Efficiency Index .

The Energy Efficiency Index (EEI) of industry is carried out taking into account energy efficiency trends at the level of various branches. For each branch, the unit consumption is expressed in terms of energy used per ton produced for energy intensive products (e.g. steel, cement, pulp & paper) and in terms of energy used related to the Industrial Production Index for the other branches. The progress observed in each branch is weighted with the share of each branch in the total industry consumption to provide the overall Energy Efficiency Index[37].

Box 11 illustrates an example of calculation of an Energy Efficiency Index in industry in the case of Brazil.

Box 11: Measuring energy efficiency in industry: Energy Efficiency Index in Brazil

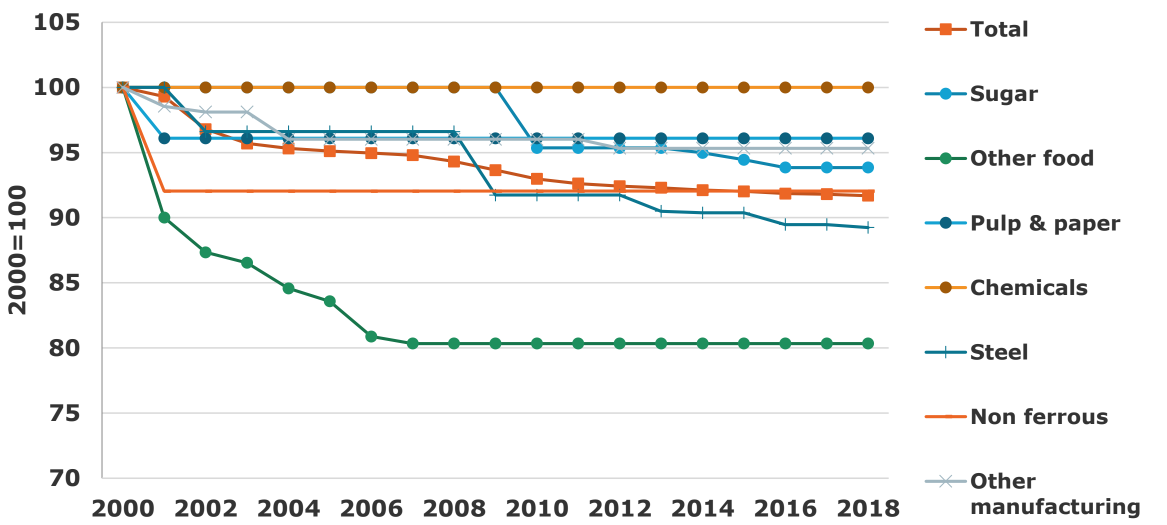
[37] See in Annex 1 for the details of EEI calculation methodology.

In the case of Brazil, the evaluation of Energy Efficiency Index[38] (EEI) of industry is carried out at the level of 11 branches:
- 5 main branches: textile, clothing & leather, chemicals, non-ferrous metals, ferroalloys and mining
- 5 energy intensive branches: sugar, steel, cement, ceramics and pulp & paper.
- 2 residual branches: other food, beverage and tobacco (i.e. food, beverage and tobacco minus sugar) and other manufacturing.

For each branch, the unit consumption is expressed in terms of energy used per ton produced for energy intensive products (sugar, steel, cement, ceramics and pulp & paper) and in terms of energy used related to the production index for the other branches.

Energy efficiency in Brazil improved by 0.5%/year (or 8%) between 2000 and 2018, as measured with the EEI (Figure 80). In other words, without energy savings since 2000, the energy consumption would have been 8% higher in 2018. All industrial branches (except chemicals) participated to this result, with largest energy efficiency improvements for steel (20%).

Figure 80: Energy Efficiency Index of industry for Brazil



Source: BIEE Cepal

[38] See in Annex 1 for the details of EEI calculation methodology. In this example, the EEI is corrected from the apparent loss of energy efficiency and corresponds to a "technical" index.

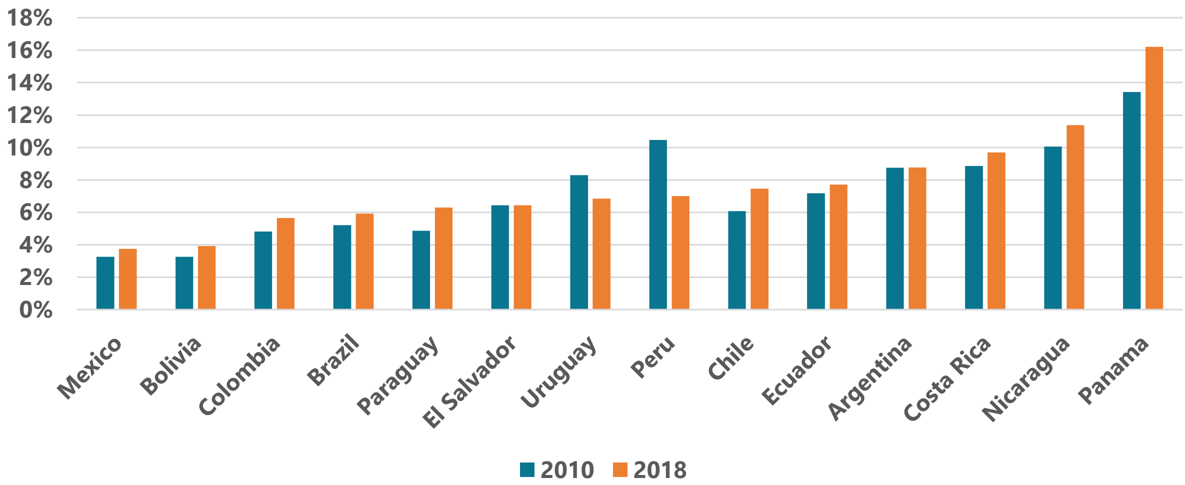
7. SERVICES

7.1. Energy consumption pattern

The service sector, also called tertiary, is made of different activities, including wholesale and retail trade, tourism (hotels, restaurants), education, health, administrations (i.e. public sector), offices (financial institutions and other private services). Public lighting is also included in the consumption of this sector.

The energy consumption of services has been increasing faster than in other sectors in most BIEE countries except Peru. Therefore, the share of services in the final energy consumption grew in most countries between 2010 and 2018. The highest share (16%) and increase (by 3 points) is observed in Panama. In Uruguay, it decreased due to the sharp increase of industry consumption (new pulp and paper mill) while in Peru transport has the fastest progression (Figure 81).

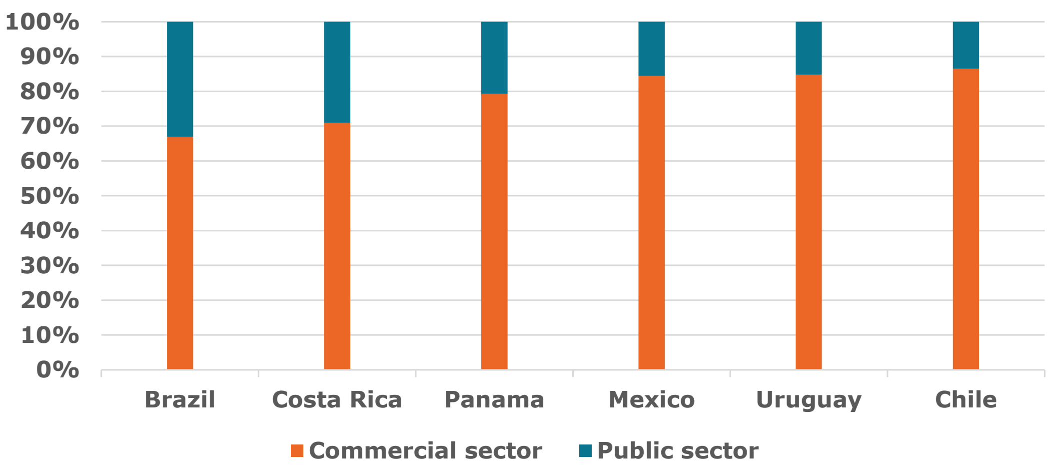
Figure 81: Share of services in final energy consumption



Source BIEE, Cepal

The commercial sector (private services) represents more than 2/3 of the consumption of the sector in most countries, up to 85% in Uruguay and 87% in Chile (Figure 82).

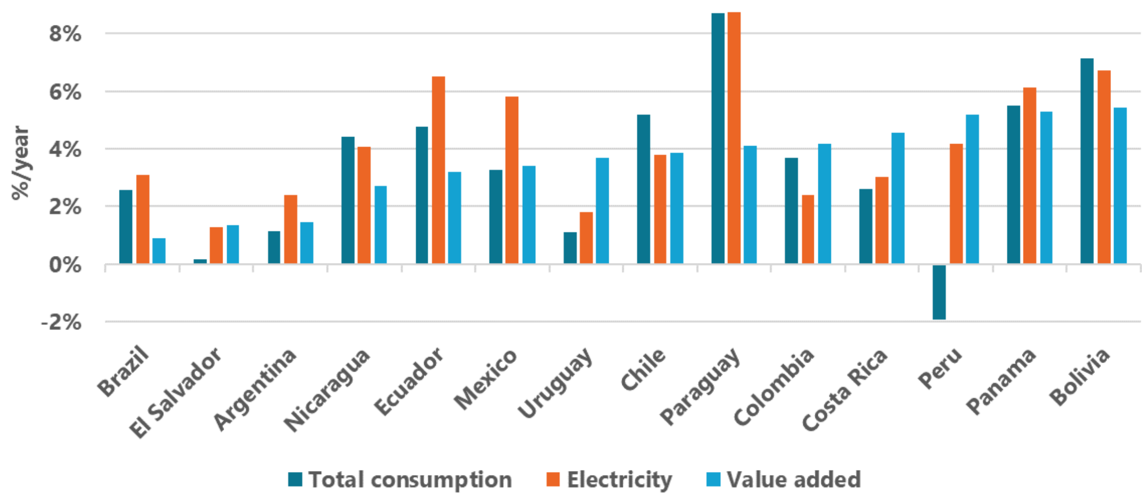
Figure 82: Energy consumption of services by branch (2018)



Source BIEE, Cepal

Total energy consumption of services grew rapidly, by more than 5%/year, in 5 countries (Panama, Ecuador, Chile, Bolivia and Paraguay), and declined in Peru (-2%/year) (Figure 83). For almost all BIEE countries, the electricity consumption is growing faster than total energy consumption. Tourism and trade are generally the two sectors that pull up consumption, mainly because of air conditioning and other specific uses of electricity. For around half of countries, energy consumption is growing faster than value added resulting in increasing energy intensity.

Figure 83: Energy consumption, electricity consumption and value added in services (2010-2018)



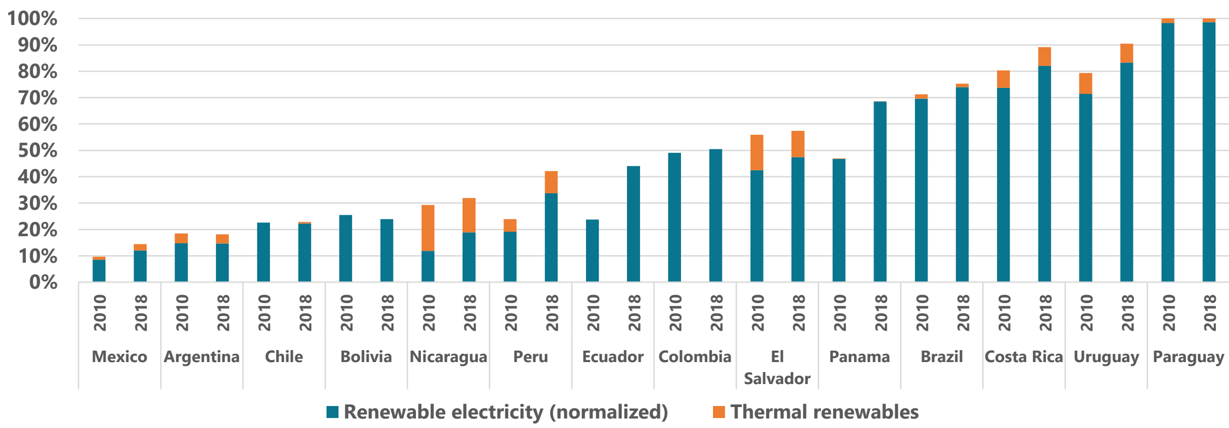
Source BIEE, Cepal

7.2. Renewables

Since services consume mainly electricity[39], countries with a high share of renewables in their power mix have a high share of renewables in services consumption. Paraguay achieves a share of 100% in 2018, while Uruguay and Costa Rica are around 90%. Countries with a power mix more relying on fossil fuels, or with a large and intensive service sector (e.g. Mexico, Argentina), have a lower penetration of renewables (Figure 84).

The share of renewable electricity has increased quite rapidly between 2010 and 2018, up to +22 points for Panama and +20 points for Ecuador.

Figure 84: Share of renewables in services sector



Source: BIEE Cepal

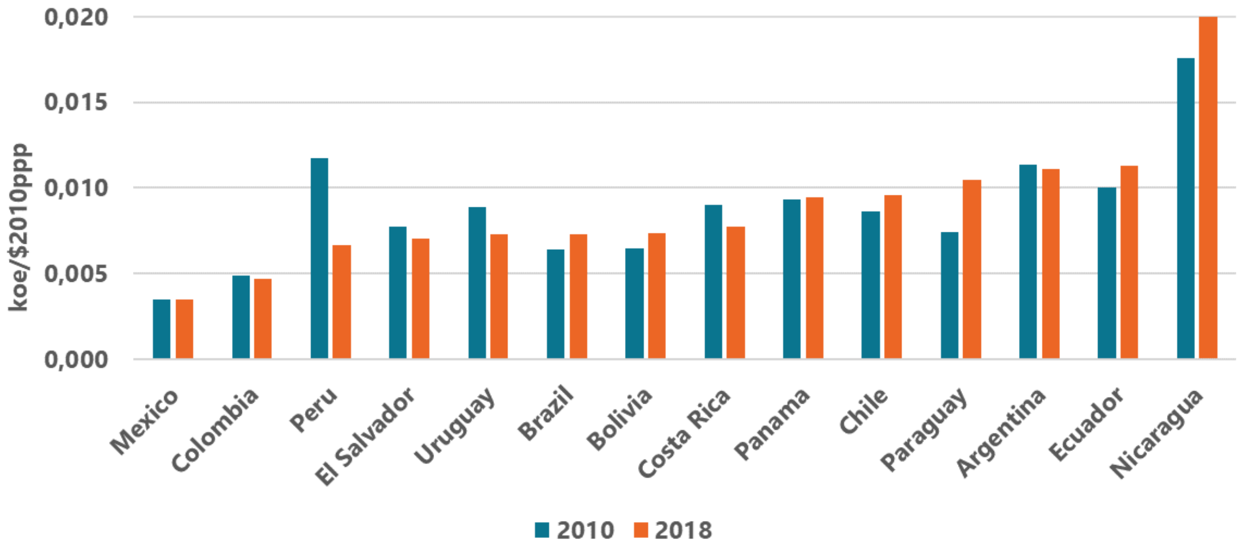
39 In all countries, the share of electricity is generally above 50% and even exceeds 90% in Brazil and Paraguay.

7.3. Energy efficiency

7.3.1. Overall energy efficiency

The energy intensity of services, defined as the final energy consumption per unit of value added at purchasing power parities, varies significantly among BIEE countries. Nicaragua has the highest intensity, which is seven-fold the intensity of Mexico (Figure 85).

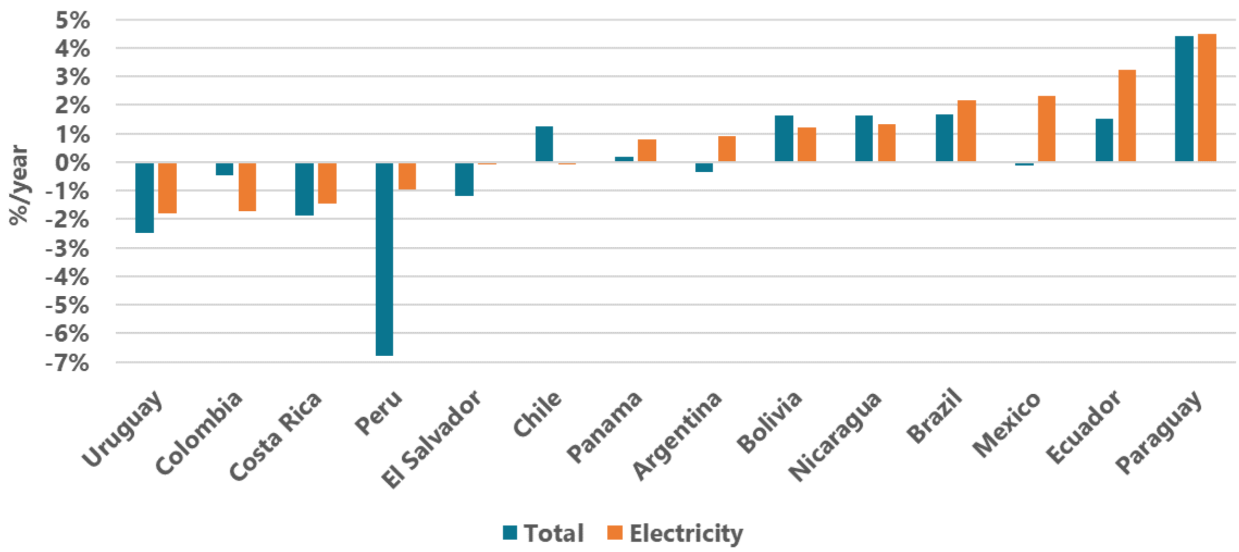
Figure 85: Energy intensity of services



Source BIEE, Cepal

The electricity intensity of services is increasing in most countries, except in Peru (-6.8%/year), Costa Rica, Colombia and Uruguay (Figure 86). The trend was the fastest in Paraguay (4.4%/year).

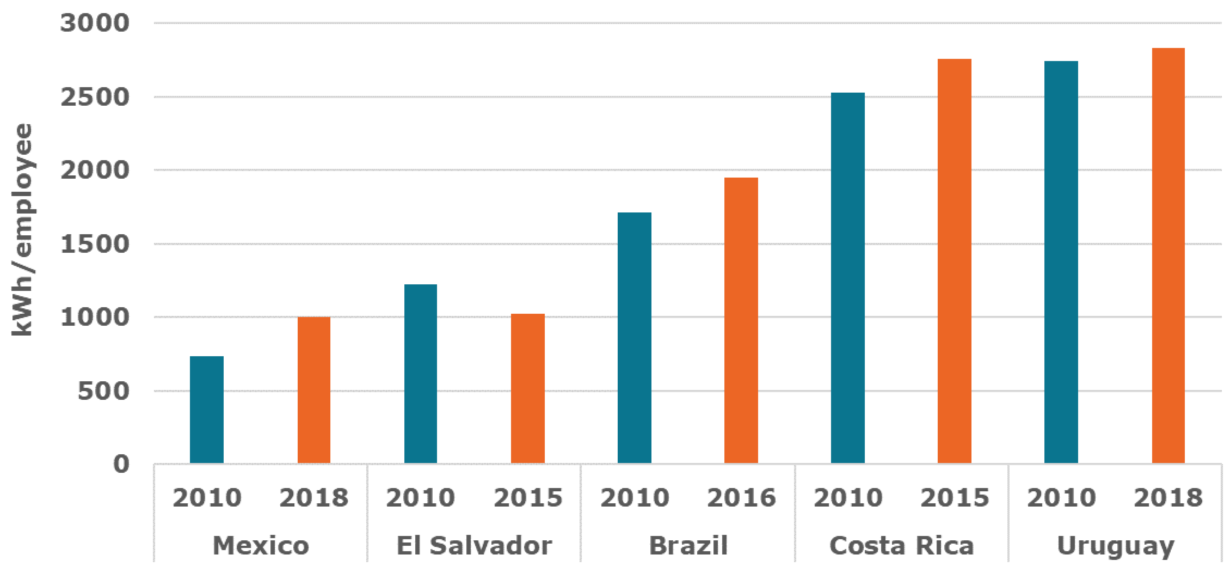
Figure 86: Trends in energy intensity of services (2010-2018)



Source BIEE, Cepal

From 2010 to 2018, the electricity consumption per employee in the services sector increased in almost all BIEE countries, notably in Mexico (+3.9%/year). This consumption is driven by improved comfort and the rapid development of information technology and communication (ICTs), particularly related to internet (Figure 87).

Figure 87: Electricity consumption per employee (kWh/employee)

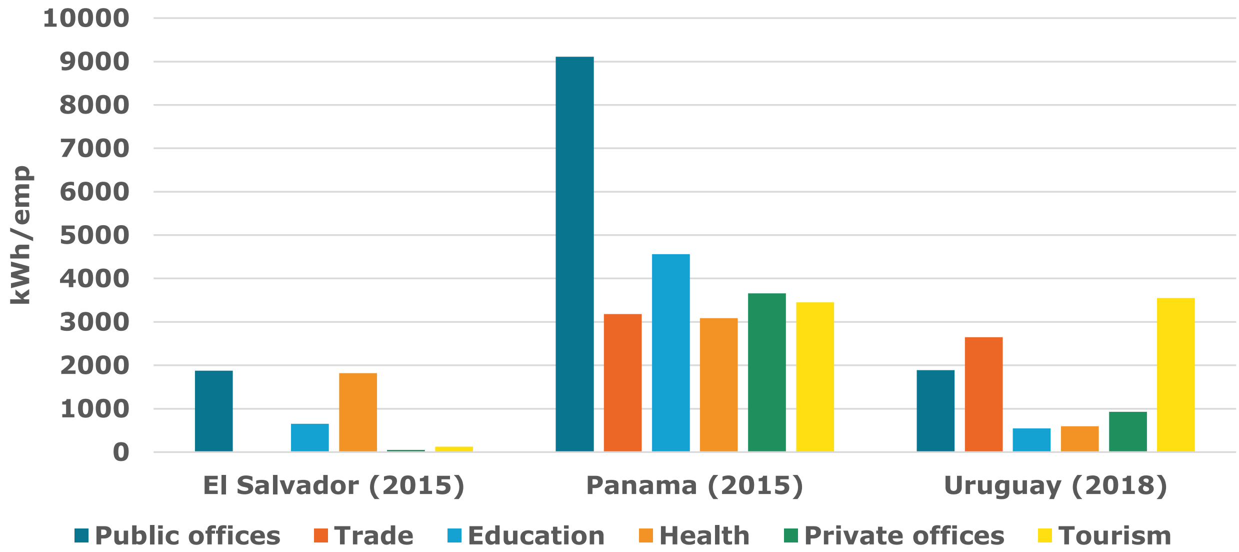


Source BIEE, Cepal

7.3.2. Energy efficiency by branch

Within the various branches, there are important discrepancies among countries in unit consumption by employee (Figure 88). For instance, in Uruguay, tourism was the sector with the highest electricity consumption per employee in 2018, followed by trade. In Panama (2015), electricity consumption per employee is particularly high in public offices.

Figure 88: Electricity consumption by branch and per employee



Source BIEE, Cepal

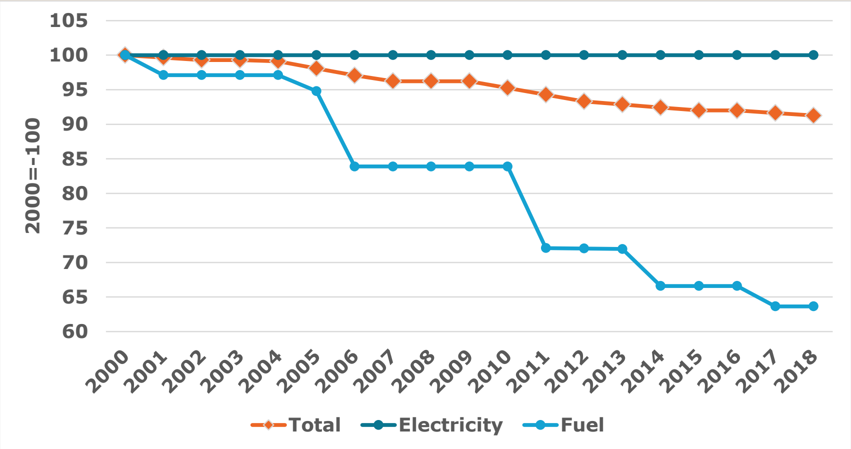
An Energy Efficiency Index (EEI) can be calculated for services as for industry by taking into account energy efficiency trends at the level of branches. For each branch, the unit consumption is expressed in terms of energy used per employee. The progress observed in each branch is weighted with the share of each branch in the total consumption of the services sector to provide the overall Energy Efficiency Index[40]. An example is shown in the case of Uruguay (Box 12).

Box 12: Measuring energy efficiency progress of services sector: case of Uruguay

In the case of Uruguay, the Energy Efficiency Index of services is calculated at the level of 6 branches: offices (public and private), health (and social work), wholesale and retail trade, tourism, education, and others[41].

Energy efficiency of services in Uruguay improved by 0.5%/year (or 9%) between 2000 and 2018, as measured with the EEI (Figure 89). In other words, without energy savings, the energy consumption would have been 9% higher in 2018. This result has been achieved thanks to efficiency improvement for fuel for all branches, with largest improvements for trade (78%). There was no improvement for electricity (except for tourism).

Figure 89: Energy Efficiency Index of services in Uruguay

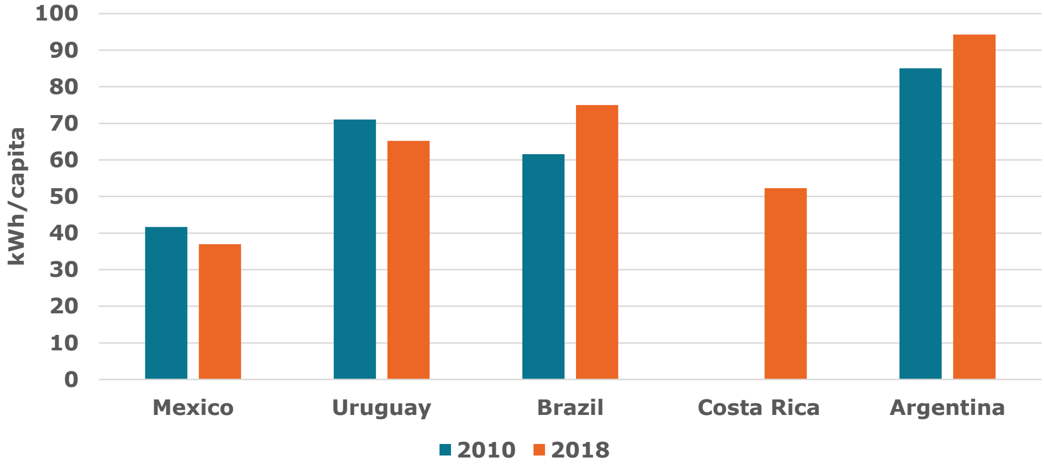


Source: BIEE Cepal

7.3.3. Public lighting

The electricity consumption for public lighting per capita ranges from 37 kWh in Mexico to around 100 kWh in Argentina. It has started decreasing in Mexico and Uruguay, thanks to the policy implemented to replace inefficient lamps but is still increasing in Argentina and Brazil.

Figure 90 : Trends in public lighting consumption per capita



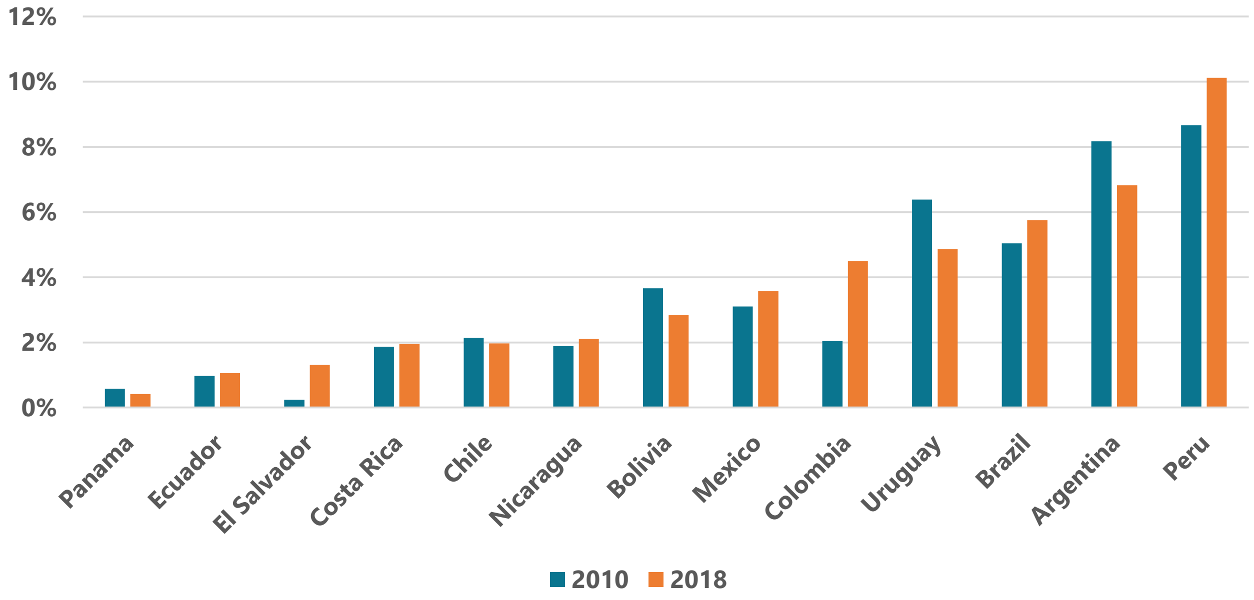
Source: BIEE Cepal

[40] See in Annex 1 for the details of EEI calculation methodology.
[41]With a separation between fuels (i.e. thermal uses) and electricity uses.

8. AGRICULTURE

In 2018, the consumption of agriculture, fisheries and forests represented 10% of the final energy consumption in Peru, 7% in Argentina and 6% in Brazil. In all other countries, this share was below 5%.

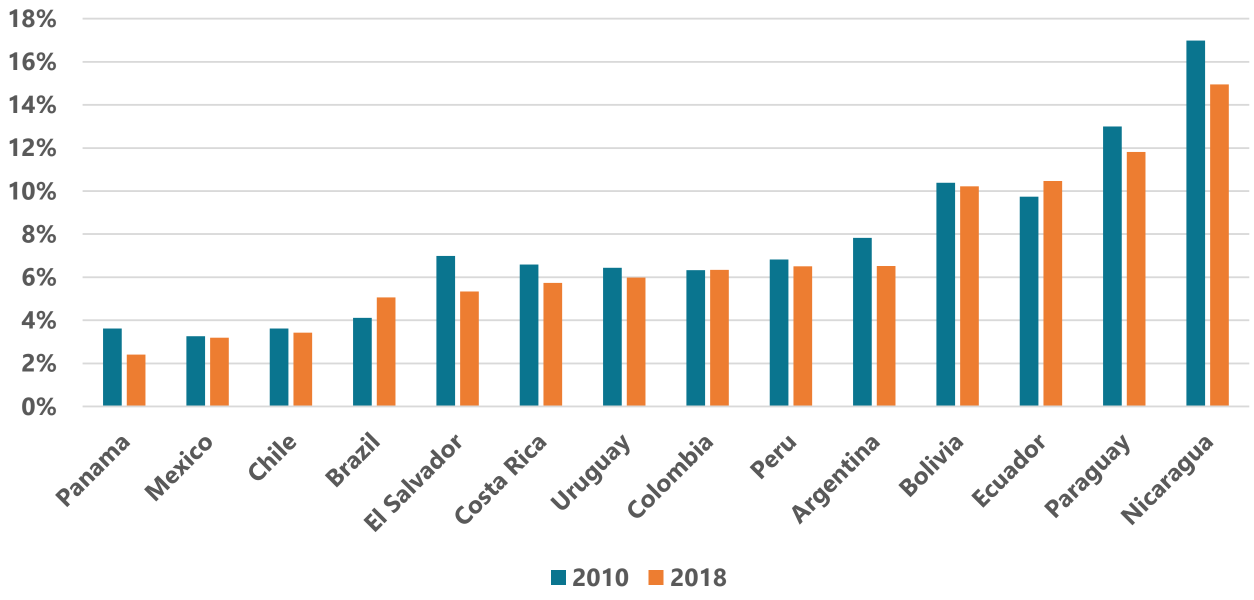
Figure 91: Share of agriculture, fishing and forestry in final energy consumption



Source: BIEE, Cepal

The value added of the sector is quite significant for the economy in Nicaragua (15%) and Paraguay (12%), even if this share tends generally to decrease (**Figure 92**).

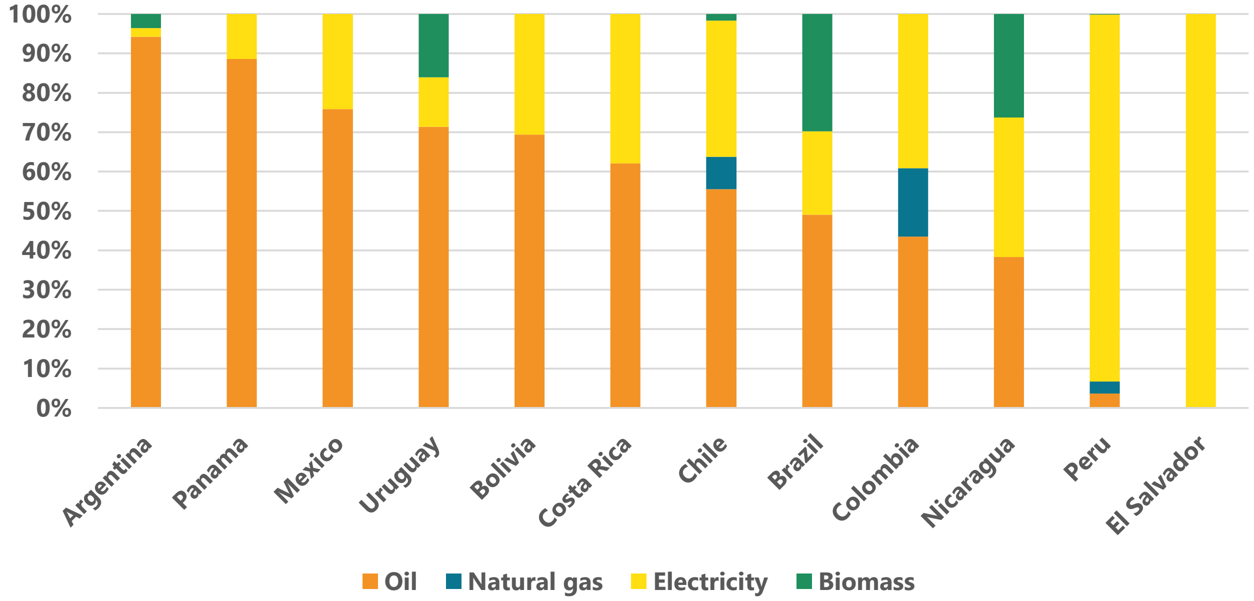
Figure 92**: Share of value added of agriculture, fishing and forestry in GDP**



Source: BIEE, Cepal

Oil is the main energy source in the agriculture sector, mainly as fuel for tractors, fishing boats and pumps (diesel and LPG). Its share was 94% in Argentina, 89% in Panama and 76% in Mexico in 2018. Electricity, mainly used for livestock farms and irrigation pumps, dominates the fuel mix in El Salvador (100%) and Peru (93%). Finally, biomass is notably used in Brazil (30%), Nicaragua (26%) and Uruguay (16%) (Figure 93).

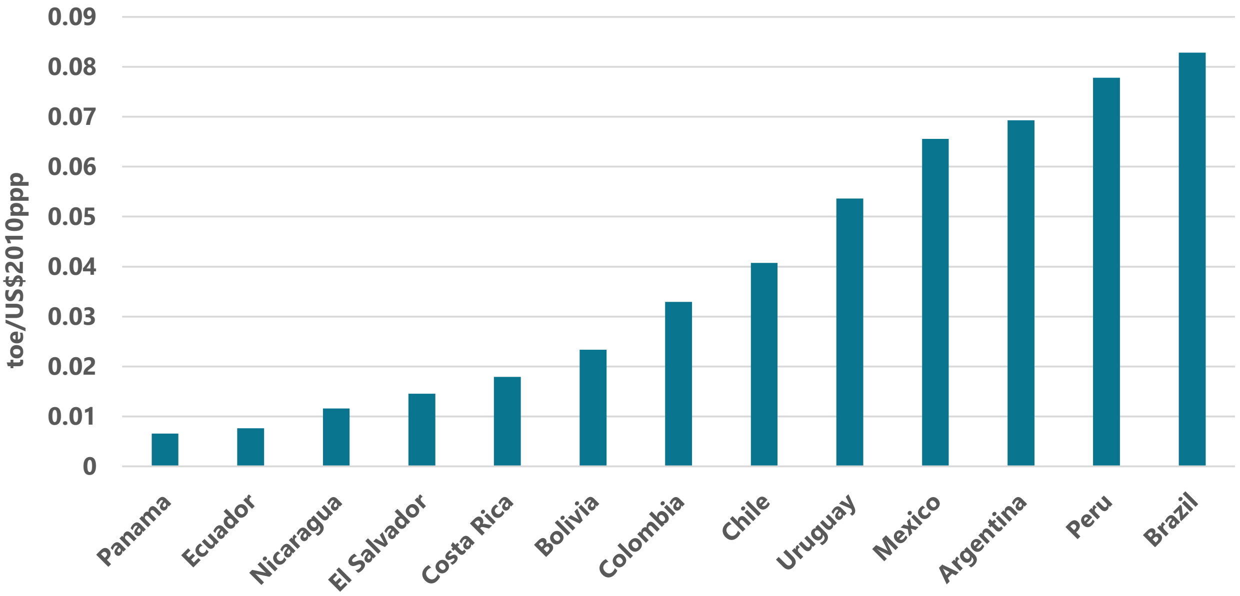
Figure 93: Consumption of agriculture, fishing and forestry by fuel (2018)



Source BIEE, Cepal

The energy intensity of agriculture, defined as the final energy consumption per unit of value added at purchasing power parities, is the highest in Brazil, Peru, Argentina and Mexico (around 0.06-0.07 toe/US$2010ppp).

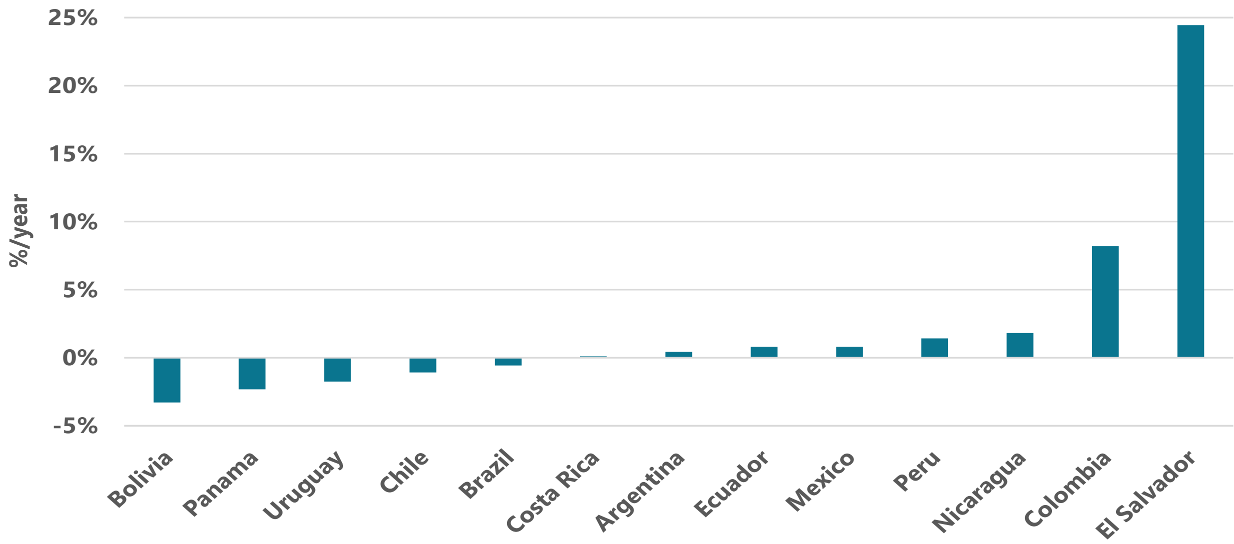
Figure 94: Energy intensity of agriculture (2018)



Source BIEE, Cepal

Colombia and El Salvador's energy intensity of agriculture strongly increased over 2010-2018, which could be explained by a fast development of intensive agriculture (Figure 95).

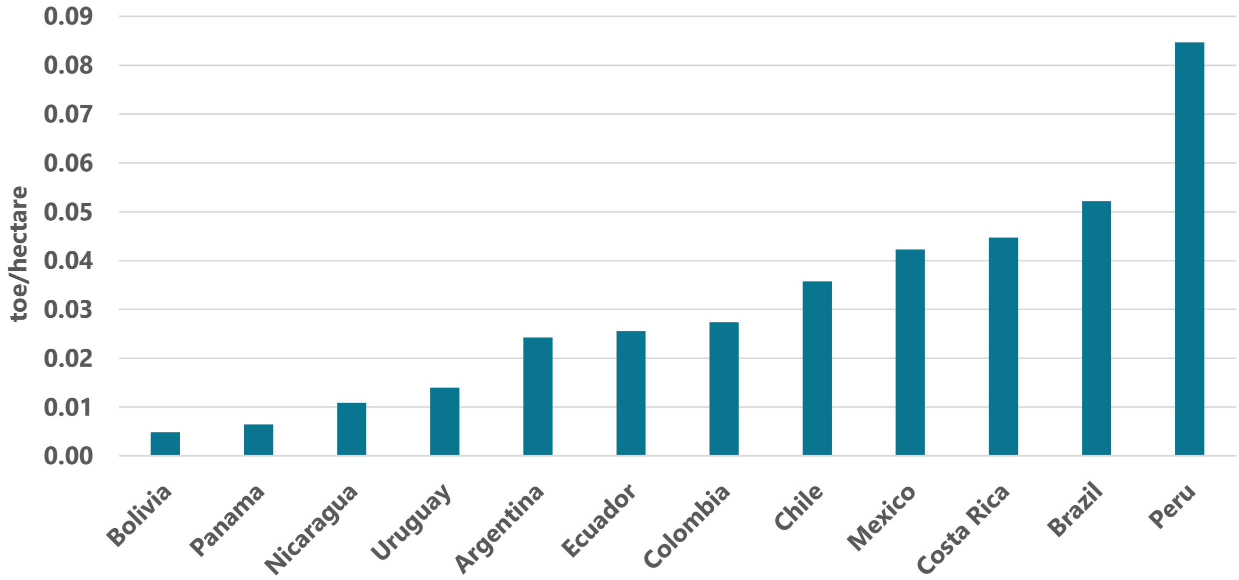
Figure 95: Trends in energy intensity of agriculture (2010-2018)



Source BIEE, Cepal

In 2018, energy consumption of agriculture per hectare ranges from less than 0.01 toe/ha in Bolivia and Panama to more than 0.08 toe/ha in Peru (Figure 96). Many factors can influence the level of this indicator: the rate of mechanization of agriculture, the share of agriculture area with irrigation (see Box 13) or the rate of equipment in electric and diesel pumps.

Figure 96: Energy consumption of agriculture per hectare (2018)

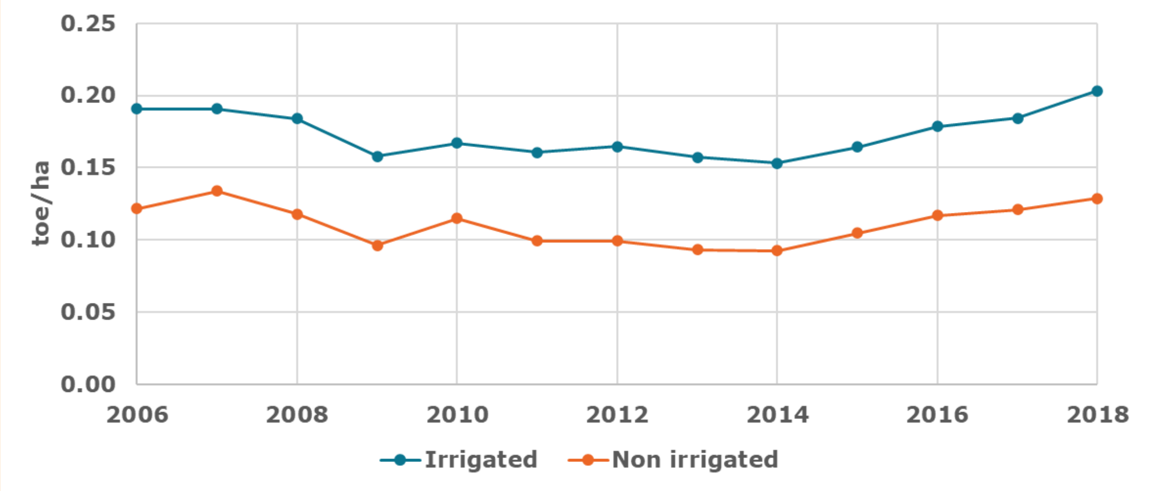


Source BIEE, Cepal

Box 13: Specific energy consumption of agriculture: the impact of irrigation

The difference between specific consumption of agriculture per sown area depends strongly on the share of irrigation. Therefore, as shown in Figure 97, irrigation is around 60% more intensive in Uruguay (around 10% of land irrigated in 2018).

Figure 97 : Specific consumption of agriculture of Uruguay: irrigated versus non irrigated



Source: BIEE Cepal

9. Conclusions

The main conclusions and findings are summarized below in the three areas of SDG 7, i.e. energy access, renewables and energy efficiency.

Energy access remains a challenge in some countries even if indicators are progressing rapidly since 2010.

- In 12 out of the 14 countries reviewed over 93% of households had access to electricity in 2018. In Nicaragua and El Salvador, the two countries with the lowest level (89% in 2018), the rate of electrification is progressing rapidly (+9 and 7 points since 2010).

- Access to clean cooking technologies remains a challenge in Nicaragua (only 55% of households with such access) and, to a lesser extent, Paraguay (67%) and Peru (74%). These three countries are gradually catching up, with a high progression since 2010 (around +10-15 points).

Renewables: their share in the power mix has seen unprecedented growth over the past decade. Their share in final energy consumption increased notably in 3 countries; it has however decreased in half of countries with a reduced use of biomass for cooking.

- The share of renewables in the power mix has increased by 20 points or more in 4 countries since 2010: Ecuador, Nicaragua, Panama and El Salvador. It progressed by 10 points in Uruguay (increase of wind, solar and biomass offset by a decrease of hydropower) and Colombia.

- The highest progression of renewables in the final consumption is observed in Uruguay (+8% points) due to the increasing use of biomass in industrial sector, followed by Panama and Ecuador (+5 points). The share of renewables "heat" (mainly cooking) has decreased in most countries. In half of countries, it is not balanced by the penetration of renewable electricity, in particular in El Salvador and Bolivia, which explain a much lower share of renewables in 2018 **than in 2010**.

- In about half of the countries, the share of renewables in households' consumption has decreased over 2010-2018, as the use of biomass decreased faster than the rise in the share of renewable electricity. In Panama, Uruguay and Ecuador, the decline in biomass was however more than offset by the penetration of renewable electricity leading to an increase of the share of renewables (around +6-7 points).

- Brazil has the highest share of renewables in transport consumption (23%) thanks to biofuels. In Argentina, Paraguay and Uruguay, the share of renewables is between 9% and 5%. The use of electricity remains marginal because of limited electrified public transport.

- The highest progression of renewables in industry is observed for biomass in Chile and Uruguay (+4 points), while the highest increase for the share of renewable electricity took place in Ecuador (+12 points), followed by Colombia and Nicaragua (respectively +5 and 7 points).

- Since services consume mainly electricity, countries with a high share of renewables in their power mix have a high share of renewables in services. Paraguay achieves a share of 100% in 2018, while Uruguay and Costa Rica are around 90%. The share of renewable electricity has increased quite rapidly since 2010 in Panama and Ecuador (by up more than 20 points).

Energy efficiency: most countries are not in line with SDG 7.3 goal stating to double the rate of improvement on energy efficiency measured with primary energy intensity. Looking at more refined indicators by sector allows to better understand the factors behind this situation and to better measure energy efficiency: improvements are significative in some sub-sectors, but quite heterogenous among countries (e.g. road transport).

- The primary energy intensity has decreased by around 2%/year in Costa Rica, Panama, Colombia, and El Salvador. Seven countries have increased the rate of "energy efficiency improvement" since 2010: Panama, Colombia, El Salvador, Costa Rica, Mexico, Ecuador and Bolivia, with for the four later a reversing of the increasing trend observed before. However, most LACs are not in line with SDG 7.3 goal stating to "double the rate of improvement in energy efficiency by 2030".

- The total energy intensity indicates how much energy is consumed to produce one unit of GDP: a decrease indicates that less energy is required but it may not be the result of energy efficiency improvements only. The final energy intensity would be a better indicator as it not affected by changes in supply, in particular in the power mix, but it will be still influenced by other factors not linked to energy efficiency (e.g. "structural changes").

- The average consumption per household has been decreasing in almost all BIEE countries between 2010 and 2018 mainly because of the substitution of biomass by more efficient fuels for cooking.

- The unit consumption per vehicle has decreased in almost all BIEE countries between 2010 and 2018. In 70% of BIEE countries, changes in the vehicles' stock composition towards a higher share of light vehicles (cars) contributed to lower the consumption per vehicle. Energy efficiency improvements for road transport can be better evaluated with the variation of an indicator of unit consumption per car-equivalent, as it is cleaned from changes in the vehicle fleet. This indicator has decreased by more than 2%/year between 2010 and 2018 in half of BIEE countries, which can be considered as the rate of energy efficiency improvement for road transport for these countries.

- The energy intensity of industry decreased rapidly between 2010 and 2018 in Panama (9%/year), El Salvador and Colombia (around 4%/year) and Nicaragua (3%/year). In five other countries, the energy intensity has been also decreasing, but less rapidly (below 1%/year). This decreasing trend can reflect energy efficiency improvement but also a growing share of less intensive industrial branches (i.e. structural changes).

- Trends in total or final energy intensities or in aggregate indicators by sector (consumption per household or per vehicle) provide an economic assessment of energy consumption but do not tell anything about the factors behind this trend, in particular energy efficiency.

- To better understand what is going on and better measure the impacts of energy efficiency programmes more detailed indicators are required, such as the indicators developed in the framework of BIEE: energy efficiency index, energy savings, decomposition of the variation of the consumption over a period and financial indicator showing the monetary savings for the consumers linked to these energy savings. Such indicators require more disaggregated data, by end-use for households, by mode of transport and by industrial branch. In countries that are regularly monitoring such data (i.e. Brazil, Mexico, Uruguay), such indicators have been calculated and used to illustrate such advanced indicators in the report. In some other countries, detailed data are also available from specific study or surveys, for instance at the occasion of the production of useful energy balance (e.g. Argentina, Chile, Costa Rica, Colombia, El Salvador, Peru); they have been used by Enerdata to estimate detailed energy consumption data by end-use for households and by mode of transport, based on a methodology developed for BIEE.

ANNEX 1 – ENERGY EFFICIENCY INDEX METHODOLOGY

The Energy Efficiency Index (EEI) measures the energy efficiency progress by main sector (industry, transport, households, services) and for the whole economy (all final consumers).

For each sector, the index is calculated as a weighted average of sub-sectoral indices of energy efficiency progress; sub-sectors being industrial branches, service sector branches, end-uses for households or transport modes.

The sub-sectoral indices are calculated from variations of specific energy consumption indicators, measured in physical units and selected so as to provide the best "proxy" of energy efficiency progress, from a policy evaluation viewpoint. The fact that indices are used enables to combine different units for a given sector, for instance for households, kWh/appliance, koe/m2, tep/dwelling, etc.
The weight used to get the weighted aggregate is the share of each sub- sector in the total energy consumption of the sector.

The table below gives a fictive example of calculation for households with only 2 end-uses in which energy efficiency gains are measured in relation to the previous year. The energy efficiency index is set at 100 for the base year (e.g. 2015) and successive values are derived by multiplying the value at t-1 by IEt /IEt - 1. The index at year t thus cumulates the incremental energy efficiency progress since the base year. In this example, EEI equals 88.6 in 2018, which means that energy efficiency improved by 11.4% between 2015 and 2018.

Principle of calculation of Energy Efficiency Index over a period (fictive example)

Specific energy consumption	**2015**	**2016**	**2017**	**2018**
Cooking (toe/household) (index)	0.85 (100)	0.83 (98)	0.82 (96)	0.82 (96)
Lighting (kWh/household) (index)	300 (100)	290 (97)	260 (87)	250 (83)
Energy consumption				
Cooking (Mtoe) (%)	20 (50)	20 (48)	20 (44)	22 (46)
Lighting (Mtoe) (%)	20 (50)	22 (52)	25 (56)	26 (54)
Energy efficiency index				
Cooking	100	98	96	96
Lighting	100	97	87	83
Total	100	97,4	90,9	88,6

This index represents a better proxy for assessing energy efficiency trends by sector (e.g. industry, households, transport, services) and for all final consumers than the traditional energy intensities relating the energy consumption to a monetary value (e.g. GDP, VA, private consumption), as it is cleaned from structural changes and from other factors not related to energy efficiency (more appliances, more cars, etc.). More information about the European Energy Efficiency Index, called ODEX, can be found at http://www.odyssee-indicators.org/registred/definition_odex.pdf.