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Colombian electricity sector: challenges and opportunities

March 2021

Creando Oportunidades

Key points

The energy transition in the world is moving toward the use of cleaner energies, in line with decarbonization and the objectives set out in different international agreements.

Non-Conventional Renewable Energy Sources (NCRES) are the focus of the transition due to their low or zero emissions and their availability. The production and storage costs of these technologies have been decreasing as the learning curve advances, which promotes an environment conducive to generating greater investment in this sector.

Covid-19 had a significant impact on the sector. Global demand for electricity experienced an unprecedented drop, and consumption patterns during lockdown shifted toward higher consumption in the residential sector and a greater share of renewable sources in energy generation. And it was not only consumption that was affected, as the pandemic also led to delays in renewable projects that were quickly relaunched with the reopening.

Key points

In Colombia, the energy transition is already underway with the renewable energy auction awarded in 2019 and the proposed schedule for the coming years; however, it is necessary to give it greater prominence. This would allow the country to reduce the vulnerability of the sector, diversifying the matrix and reducing dependence on water resources, which are highly susceptible to climatic anomalies.

The country's potential for the exploitation of Non-Conventional Renewable Energy Sources is high due to its climatic and geographic conditions. And, in addition to this, it would favor areas and regions of the country that are currently not interconnected and have almost no generation capacity.

Going forward, electrical energy will be one of the key energy sources in this transition, as it will be an important substitute in the sectors that generate the greatest amount of greenhouse gases today. In Colombia, the inclusion of Non-Conventional Energy Sources in the energy matrix will be fundamental to ensure the sustainability of the sector.

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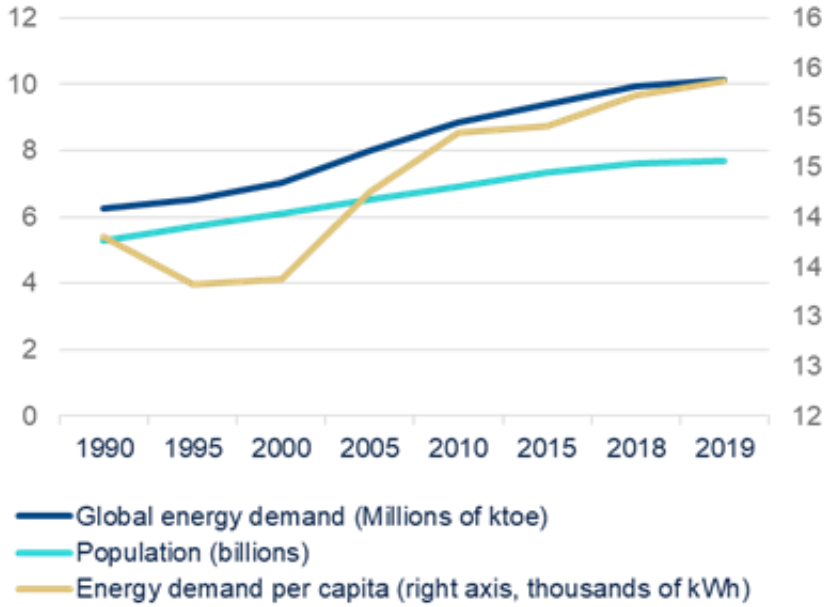
01

The current state of the electricity sector

1. International overview

Energy consumption has historically been determined by economic and population growth and technological developments

ENERGY DEMAND AND GLOBAL POPULATION
(MILLIONS OF KTOE, BILLIONS OF PEOPLE AND THOUSANDS OF KWH)

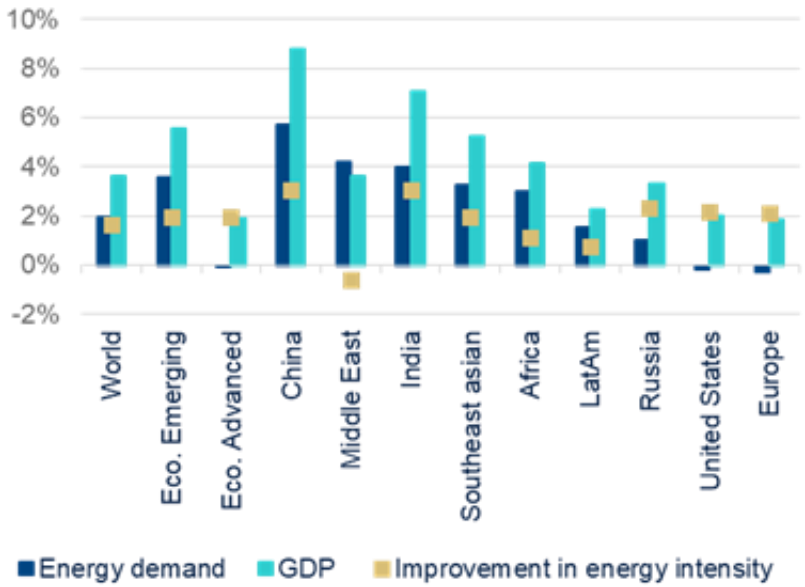


- The modern world is synonymous with energy consumption. Technological and scientific developments have been underpinned by access to energy and its ability to meet growing demand.
- Energy demand has grown 3.5% on average over the last 30 years, while the population has expanded by 1.2% and the world's GDP by 6% annually, showing the significant gains that have been made in energy efficiency and installed capacity.

G: found in the Glossary.
Source: BBVA Research based on data from the World Bank and IEA G.

Regional dynamics are different and energy efficiency improvements vary around the world

GDP, ENERGY DEMAND AND ENERGY INTENSITY
(ANNUAL CHANGE, GW[G], 2000–2019 AVG.)

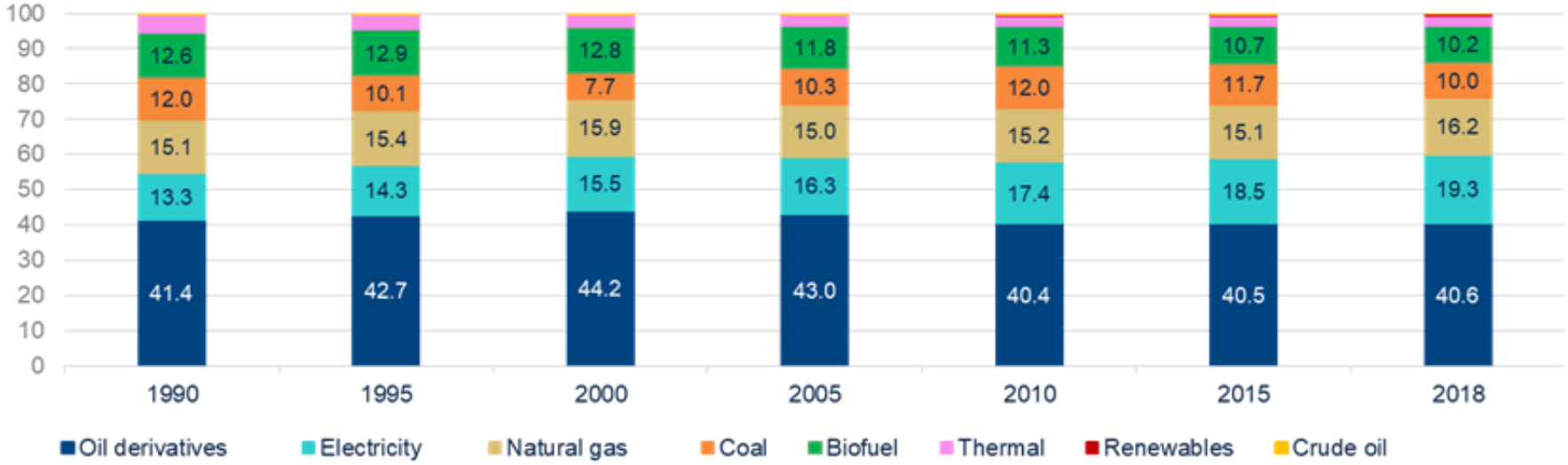


- The energy intensity[G] of the world economy improved by an average of 1.6% per year due to structural changes, lower energy demand in developed countries and an increase in efficiency.
- On average, energy intensity levels remain higher in emerging economies than in advanced economies. For example, to produce USD 1000, measured in PPP, 0.12 metric tons of oil are needed in China, while 0.10 metric tons are needed in the USA and 0.07 in Europe.

Source: BBVA Research based on data from IEA[G].

Electricity represents the second most important source of final energy consumption in the world

GLOBAL ENERGY DEMAND BY SOURCE
(SHARE OF TOTAL, %)

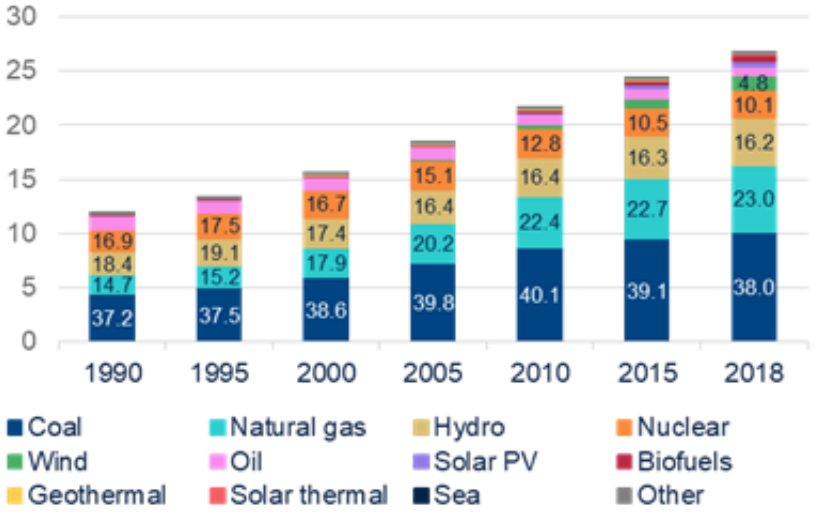


Source: BBVA Research based on data from IEA[G].

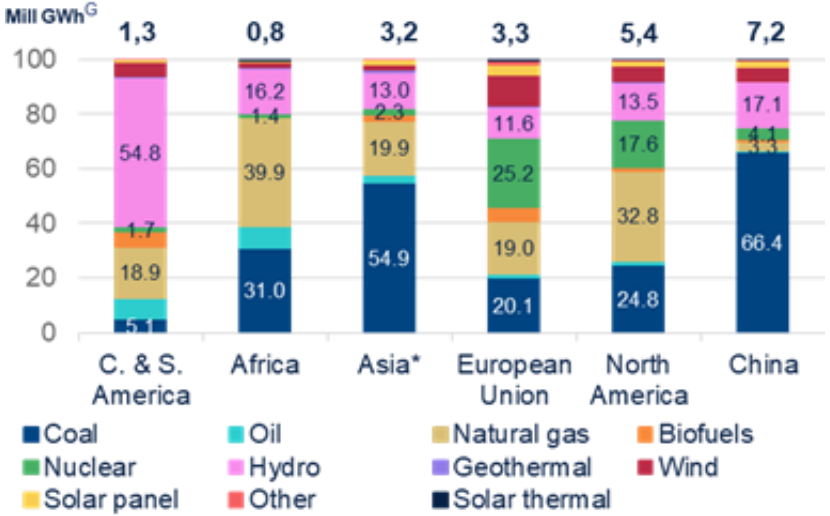
In addition, there is a growing trend in the share of electricity in global consumption

At the generation level, the main source of electricity is still coal, despite efforts for greater diversity

GLOBAL ELECTRICITY GENERATION BY SOURCE
(MILLIONS OF GWH[G] , LABELS ARE % OF THE TOTAL)



ELECTRICITY GENERATION BY SOURCE AND REGION
(% OF TOTAL AND TOTAL IN MILLIONS OF GWH[G], 2018)

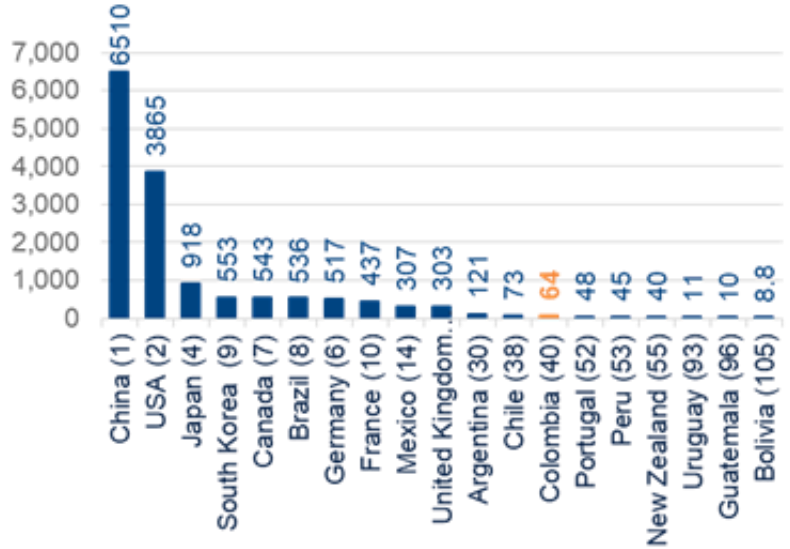


Source: BBVA Research based on IEA data.

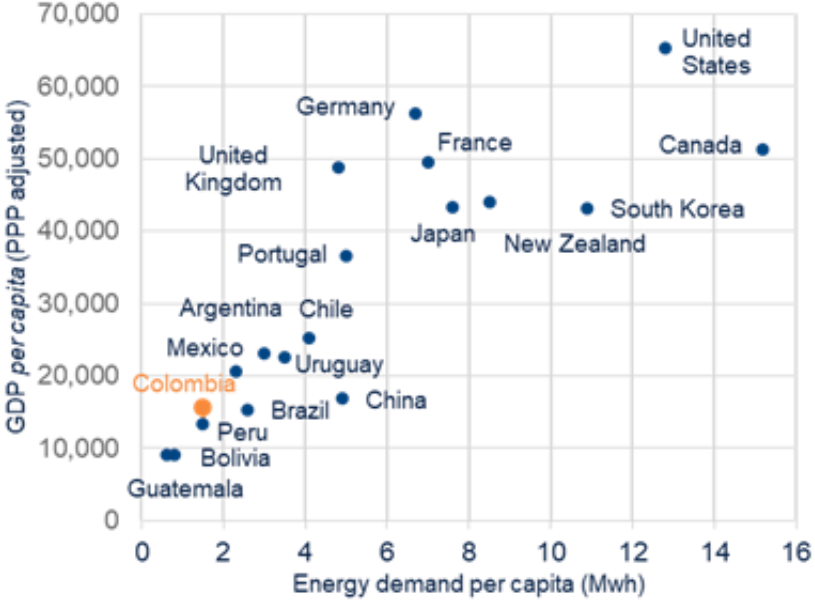
In the case of Central and South America, the main source of electricity generation is water, and the percentage share of oil is lower than the global average.

Per capita electricity consumption depends, to a large extent, on the degree of development of the countries. In Colombia, consumption is low

ELECTRICITY DEMAND BY COUNTRY
(TW^G, GLOBAL RANKING IN PARENTHESES, 2019)



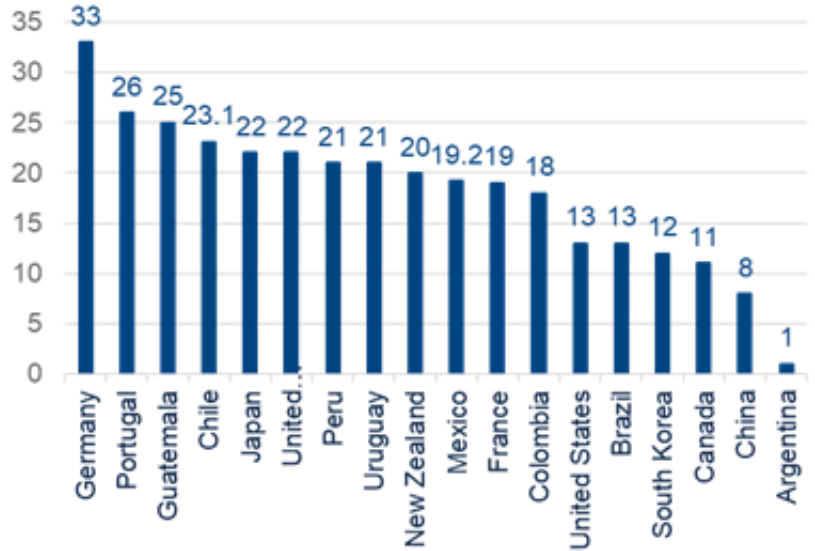
PER CAPITA ELECTRICITY DEMAND BY COUNTRY
(KW^G, GLOBAL RANKING IN PARENTHESES, 2019)



Source: BBVA Research based on data from Index Mundi, IEA and the World Bank

Electricity prices depend, to a large extent, on the tax burden and available generation sources of each country

AVERAGE PRICE OF RESIDENTIAL ELECTRICITY
(USD CENTS PER KWH[G], 2019)



- In Germany, the country with the highest electricity costs today, the tax burden on the residential segment is quite high. This makes the price of energy one of the highest in the region, even above country peers with similar generation costs.

- The cost of electricity in Argentina is among the lowest in the world. This is related to the country's high subsidized percentage for consumption.

Source: BBVA Research based on data from Statista.

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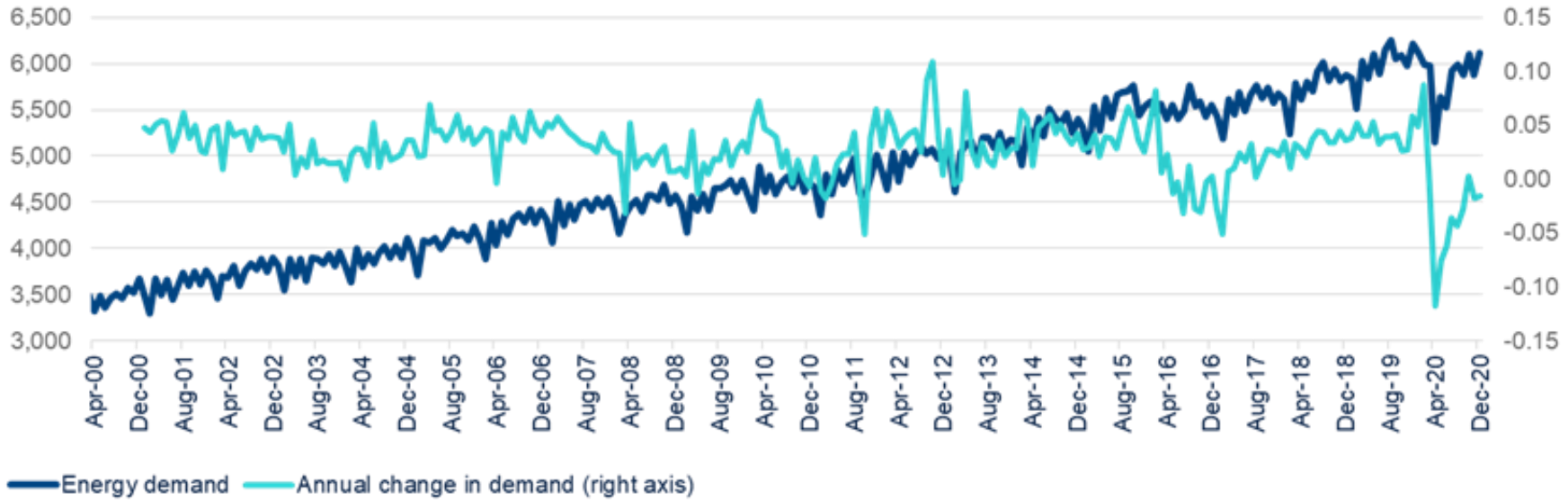
01

The current state of the electricity sector

2. In Colombia

In Colombia, over the last 20 years, the demand for electricity has grown by an average of 5% per year

ENERGY DEMAND
(GWh[G], ANNUAL CHANGE, %)



Source: BBVA Research based on data from XM[G].

The residential segment has a much higher share compared to large companies, showing the limited degree of industrialization of the country

TOTAL ELECTRICITY CONSUMPTION
(% OF TOTAL, CUMULATIVE 2020)

70.4%

RESIDENTIAL AND SMALL BUSINESSES

29.6%

LARGE COMPANIES

ELECTRICITY IN LARGE MAIN-SECTOR COMPANIES
(% OF TOTAL, CUMULATIVE 2020)

INDUSTRY
42.6%

MINING
25.4%

TRADE
5.4%

PUBLIC ADMIN.
5.4%

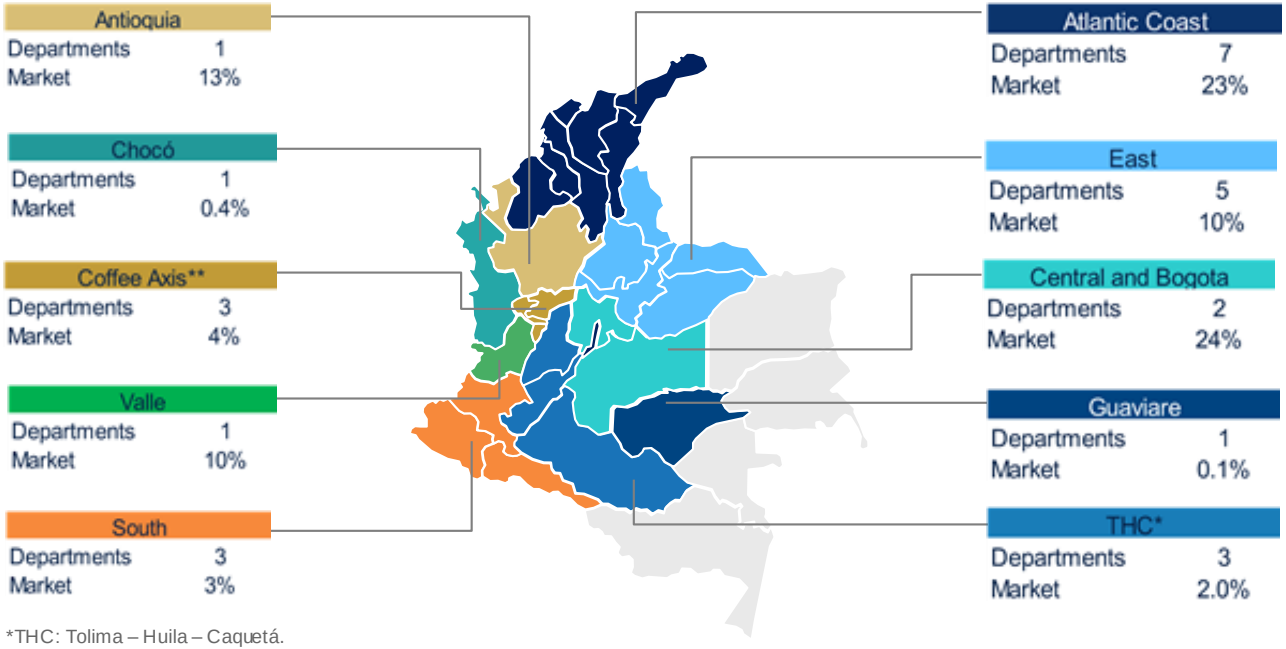
AGRO
3.7%

*Large companies refer to unregulated demand. Residential and small businesses represent regulated demand.
Source: BBVA Research based on data from XM[G] and UPME[G]

In the world, final electricity consumption by industry represents slightly more than 40%, and in Colombia this percentage is close to 30%.

At the regional level, the central area of the country is the largest electricity demander, followed by the Atlantic Coast and Antioquia

ELECTRICITY DEMAND BY REGION
(% OF TOTAL, DEC-20)

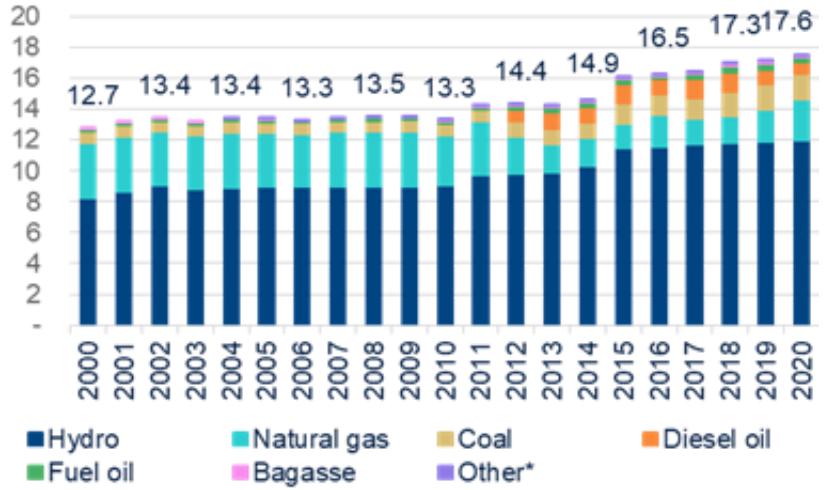


Region	Demand Dec-20 (GWh)
Atlantic Coast	1410.0
Antioquia	824.5
Chocó	21.6
Valle	590.3
South	172.4
THC*	121.3
Guaviare	5.8
Central	1440.6
East	641.3
Coffee Axis**	236.9

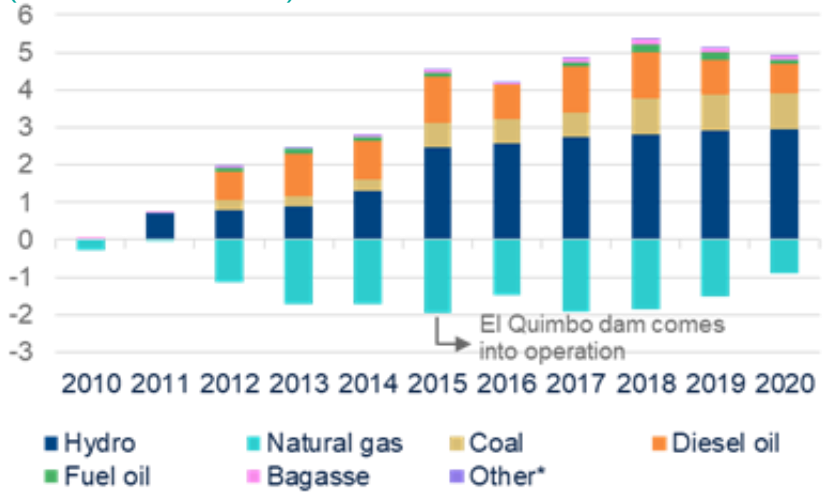
*THC: Tolima – Huila – Caquetá.
**Coffee Axis: includes Caldas, Risaralda and Quindío.
Source: BBVA Research based on data from XM.

Colombia's electricity generation capacity has grown by an average of 1.7% over the last 20 years

NET GENERATION CAPACITY BY SOURCE
(GW[G])



CHANGE IN NET GENERATION CAPACITY BY SOURCE
(CHANGE FROM 2009)

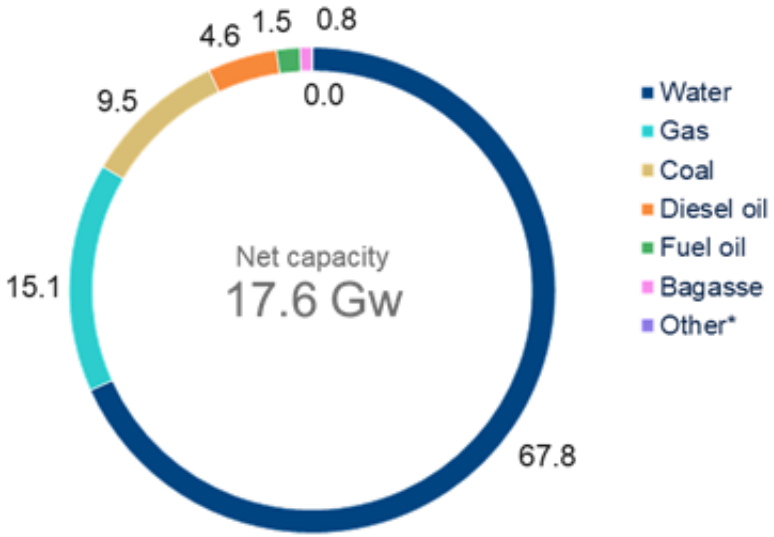


*Other: includes solar, wind.
Source: BBVA Research based on data from XM[G].

The main investments and growth of installed capacity in the country have been made on the hydropower front. As of 2012, diesel oil was included in the energy matrix, gaining a non-negligible share.

The Colombian energy matrix is mostly clean, but with a high dependence on climatic conditions

ELECTRICITY MATRIX IN COLOMBIA
(% OF TOTAL GENERATION CAPACITY, 2020)

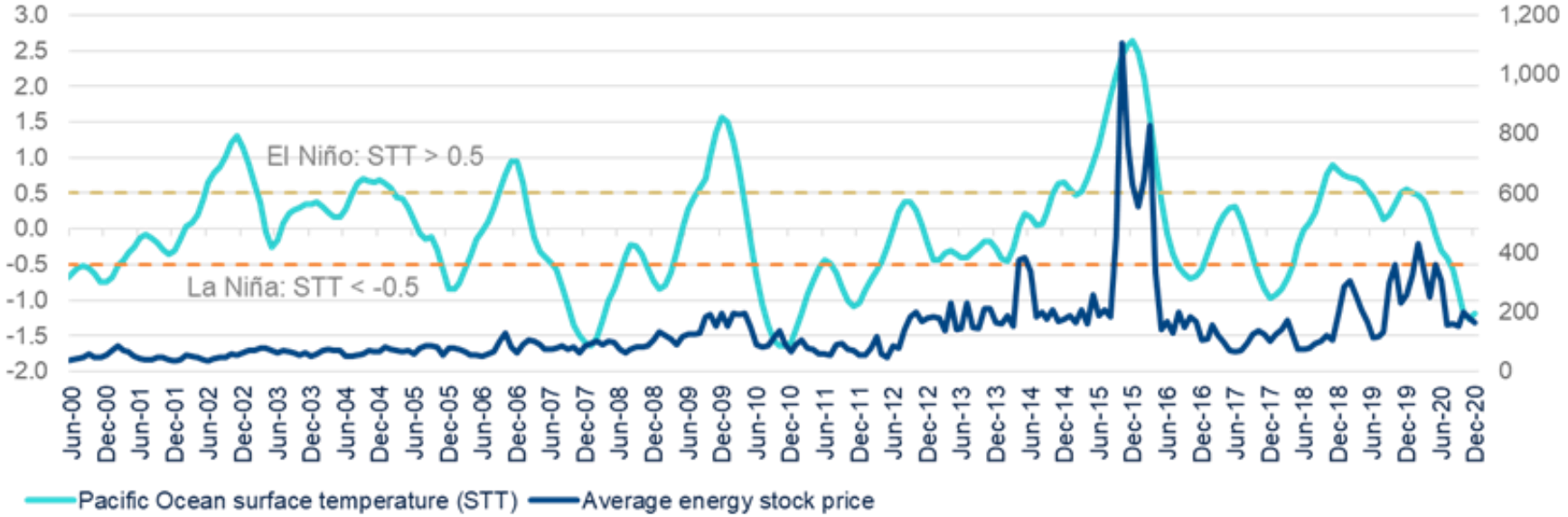


- 68% of the country's installed generation capacity is concentrated in water resources. This causes high volatility of listed energy prices, as they are subject to the variability of weather conditions.
- Natural gas represents the second largest generation source. This resource, although a fossil fuel, has lower emissions than other fossil fuels, such as oil or coal, and is considered a clean source.

Source: BBVA Research based on data from XM[G].

Given this composition, prices have a high volatility that, in the presence of anomalies, have reached variations of 300%

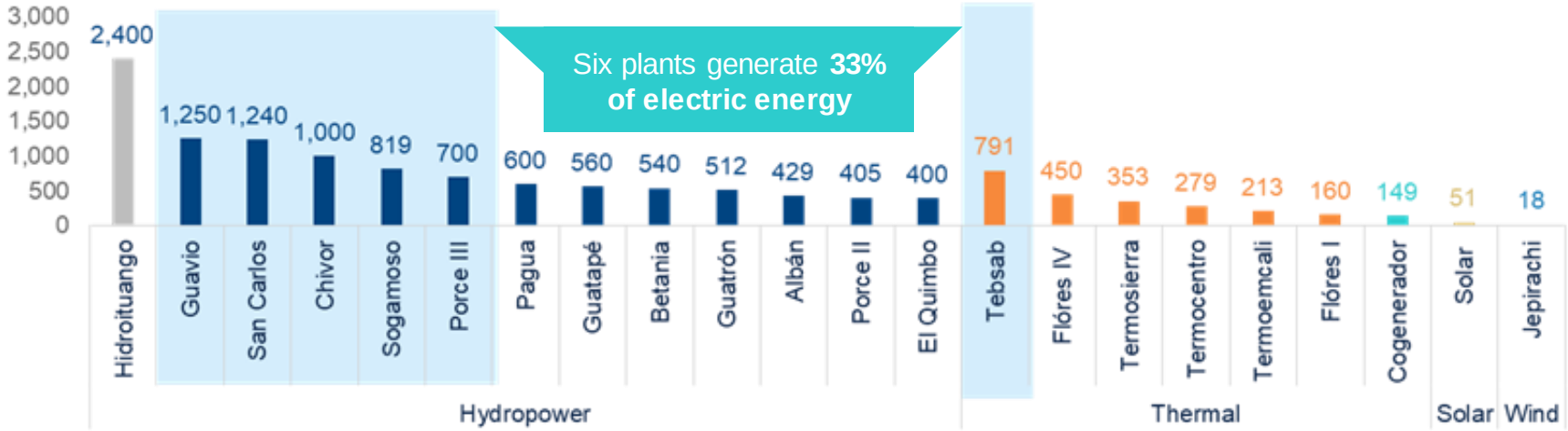
ENERGY STOCK PRICES AND PACIFIC OCEAN SURFACE TEMPERATURE
(PESOS PER KW[G], C°)



Source: BBVA Research based on data from XM[G] and NOAA

In addition to the concentration in generation sources, there is also a significant concentration at the level of generation plants

NET GENERATION CAPACITY BY MAIN PLANTS
(MW/H[G])



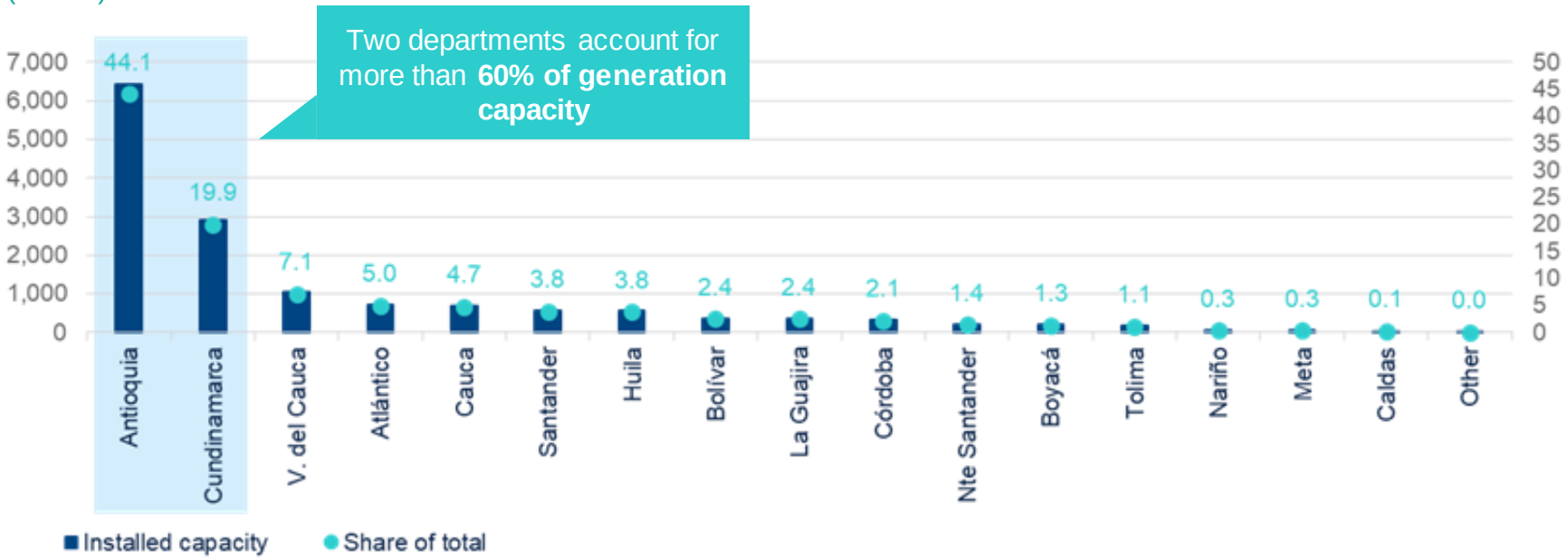
Source: BBVA Research based on data from XM[G].

Hidroituango will account for a significant increase in the country's net generation capacity, bringing the hydropower component close to what its two largest plants contribute today.

As well as installed capacity by regions of the country, which increases the dependence on national interconnection

NET GENERATION CAPACITY BY DEPARTMENT

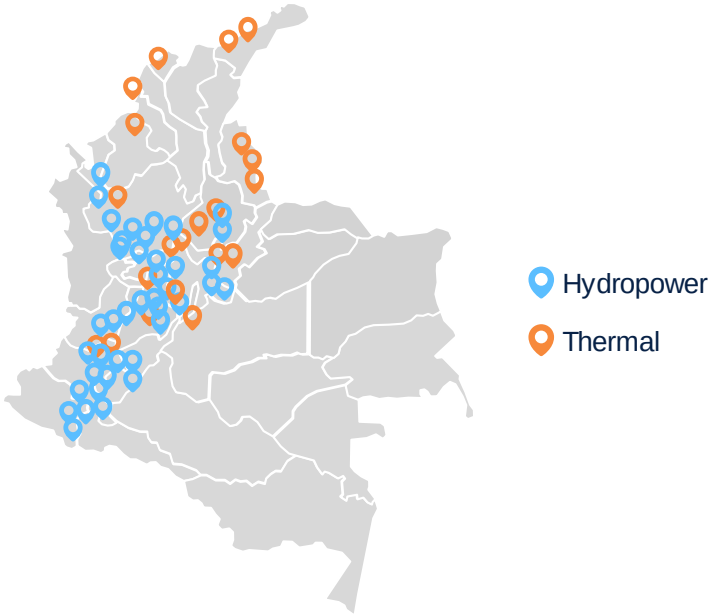
(MW/H[G])



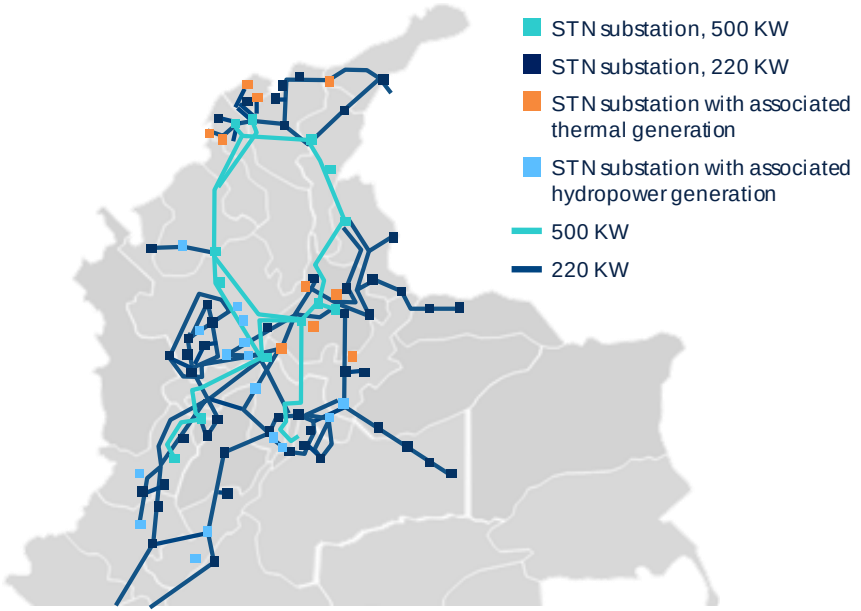
Source: BBVA Research based on data from XM[G].

Electricity generation and distribution in Colombia has low penetration in the southeastern region

LOCATION OF GENERATION PLANTS BY SOURCE
(ENERGY SOURCE)



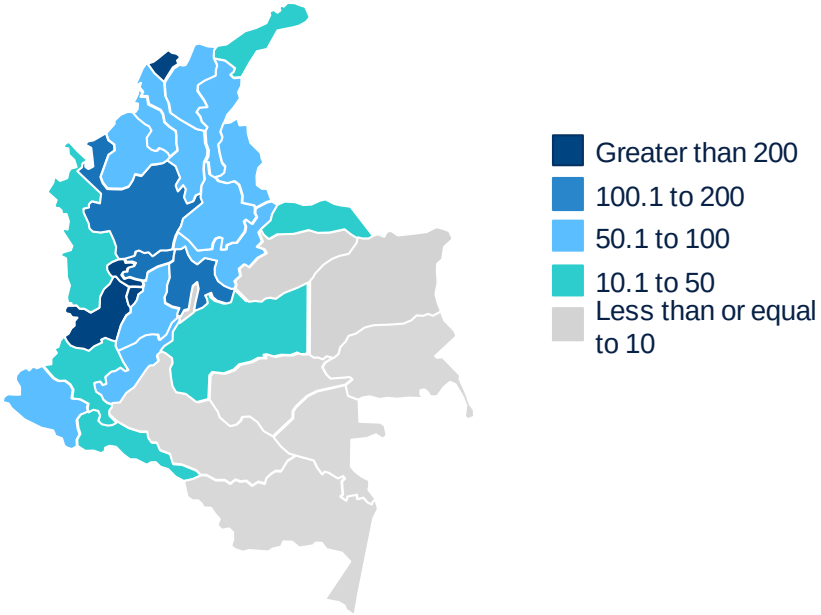
TRANSMISSION NETWORK OF THE NATIONAL INTERCONNECTED SYSTEM
(DISTRIBUTION LINES)



Source: BBVA Research based on data from XM[G].

And despite having a smaller population, access to these services is much lower than in the rest of the country

POPULATION BY DEPARTMENT
(PEOPLE PER KM/2, 2019)

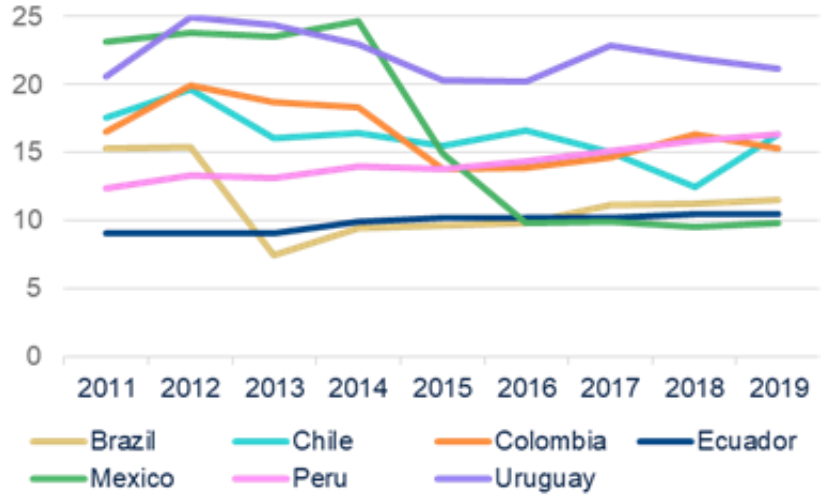


LIGHTS IN COLOMBIA
(2019)

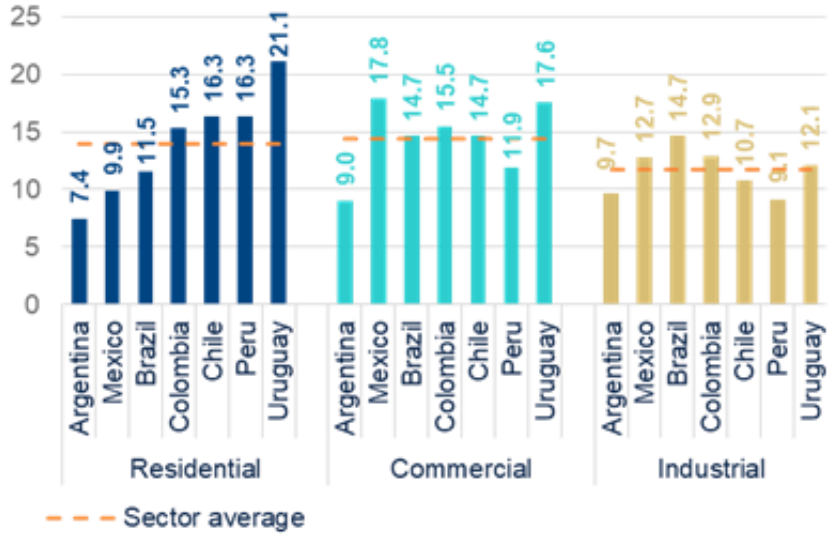
Source: BBVA Research based on data from DANE and Night Earth.

In the region, the highest costs are for the commercial sector. In the case of Colombia, the average price is in the middle of the range

RESIDENTIAL ELECTRICITY PRICES IN LATAM
(USD CENTS PER KWH[G], 2019)



PRICE OF ELECTRICITY BY SEGMENT
(USD CENTS PER KWH[G], 2019)



Source: BBVA Research based on data from UPME[G].

Mexico has recorded a drop in the average price of residential electricity since 2014 due to a change in the generation matrix toward a combined cycle that was favored by the price of gas.

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02

Energy transition

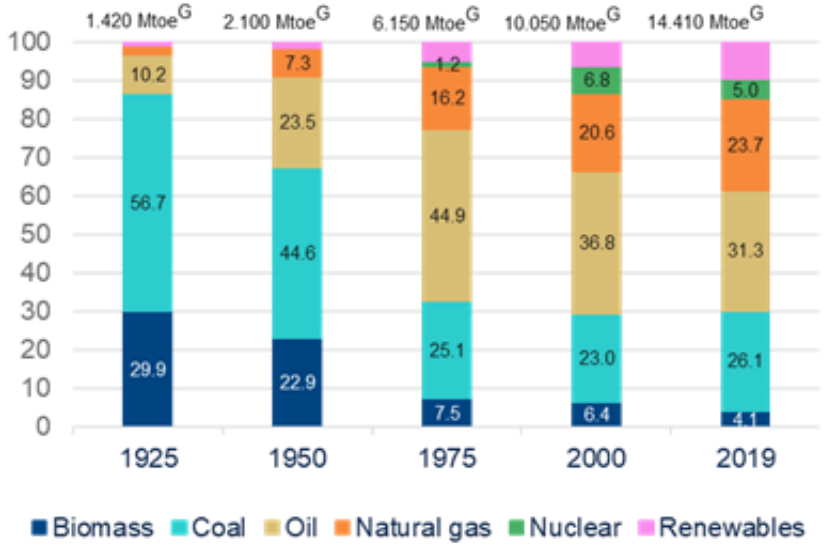
supported by Non-Conventional Renewable Energies

The global transition to clean energy sources has been slow and has been marked by three major moments of change

1	2	3
Expansion of oil use, positioning it as the main energy source	Growth in the use of natural gas Development of nuclear energy	Development of new technologies for the generation of non-hydro renewable energy

Transition to cleaner energy sources

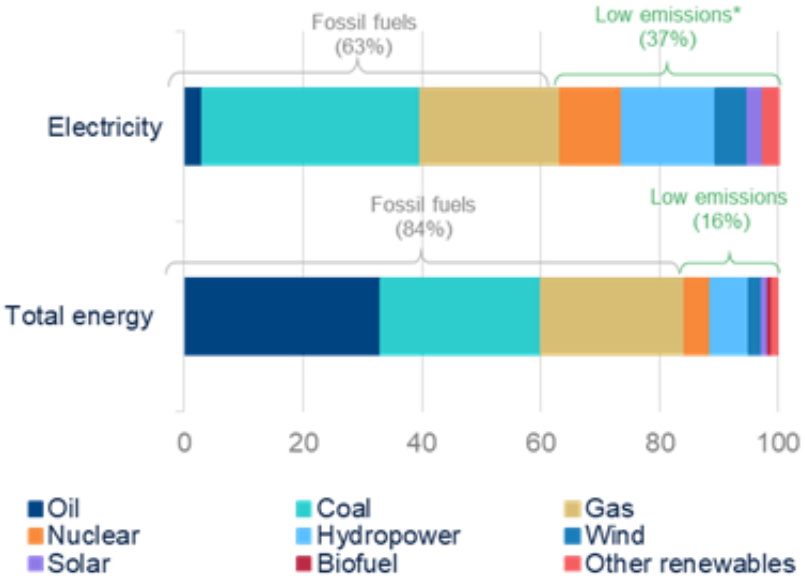
GLOBAL ENERGY DEMAND BY TYPE OF FUEL
(% OF TOTAL)



Source: BBVA Research based on data from IEA[G].

84% of the world's energy is generated from fossil fuels; a lower percentage for electricity but still quite high

BREAKDOWN OF ENERGY GENERATION AND ELECTRICITY BY SOURCE
(% OF TOTAL)

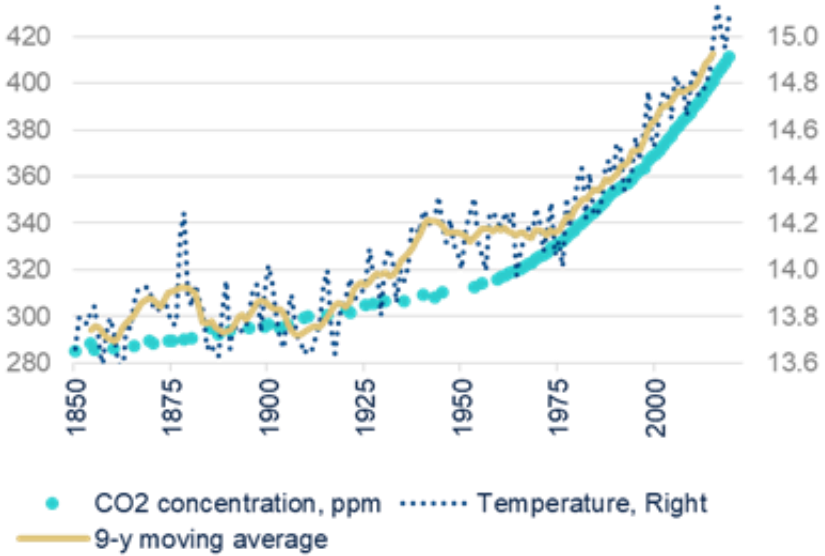


- The use of oil and coal, energy sources with high Greenhouse Gas Emissions (GHG[G])**, still continues to predominate in energy generation.
- Electricity generation accounts for 37% of low-emission sources. The share of hydropower sources is noteworthy, as they account for nearly 50%.

**GHG: Greenhouse gases. *Low emissions: includes nuclear energy.
Source: BBVA Research based on data from BP.

The accumulation of GHG* by human production activity is having a considerable impact on the global temperature

CO2 EMISSIONS AND THE EARTH'S TEMPERATURE
(PARTS PER MILLION AND °C)



- The gap between the observed temperature change and the temperature change generated by natural conditions has widened significantly since the 1980s, which may be associated with industrialization processes in emerging countries such as China and India.

- Of the GHG* emissions generated worldwide, 65% come from fossil fuels. Of these, CO2 represents one of the most significant GHGs today. For example, in the United States, CO2 emissions account for 85% of total emissions in the country.

*GHG: Greenhouse gases
Source: BBVA Research based on data from Data World and Emissions Gap Report (2020).

However, the world is increasingly aware of the importance of reducing and establishing commitments on GHG* emissions

Kyoto Protocol

Aims to reduce emissions of six greenhouse gases by setting 5% reduction targets compared to 1990 emissions for 38 industrialized countries and the EU, with compliance by 2020.

87 COUNTRIES

SIGNED 1997

BECAME EFFECTIVE 2005

Paris Agreement

Aims to strengthen the global response to the threat of climate change by establishing GHG* reduction measures and limiting the global temperature increase to less than 2°C (latest target: 1.5°C).

195 COUNTRIES

SIGNED 2014

BECAME EFFECTIVE 2016

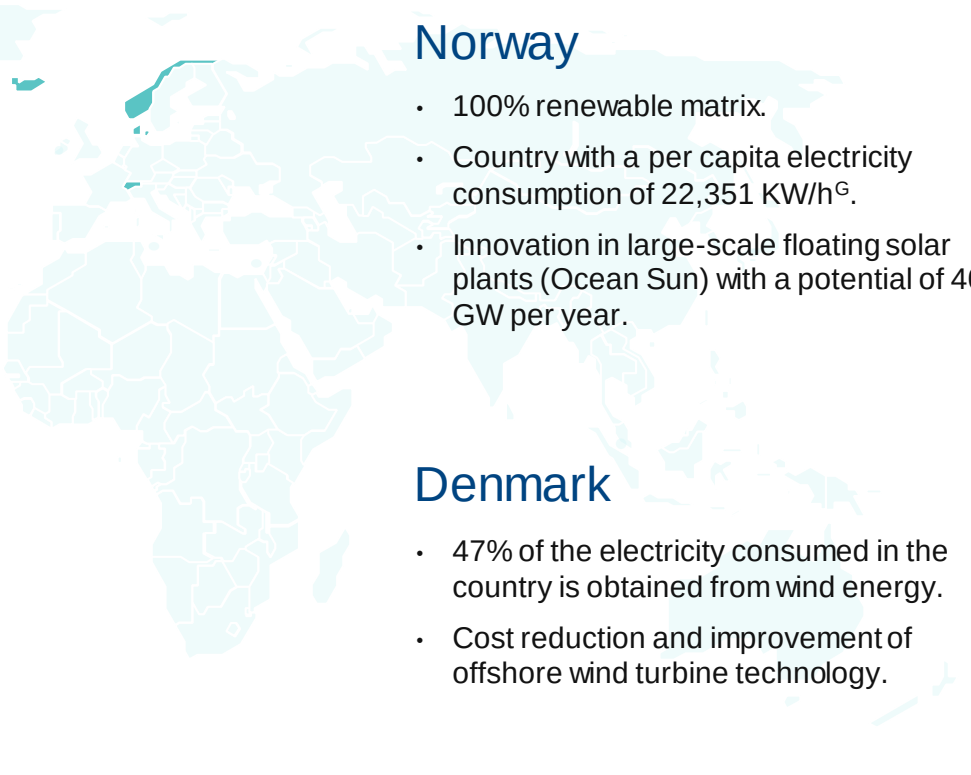
SDGs[G]

A group of global goals that were set to address various issues of concern to the world.

- **Objective 7:** Affordable and clean energy.
- **Objective 13:** Climate action.

*GHG: Greenhouse gases.
Source: UNCC[G].

Some successful cases of energy transition show us that it is a process that requires the active participation of governments



Iceland

- 100% renewable matrix (75% hydroelectric, 25% geothermal).
- Country with the highest electricity consumption per capita, with 50,409 KW/h[G], seven times that of Spain.
- Investment of USD 9.1 billion in renewable energy by 2018, which is about 35% of the 2019 GDP.

Norway

- 100% renewable matrix.
- Country with a per capita electricity consumption of 22,351 KW/h[G].
- Innovation in large-scale floating solar plants (Ocean Sun) with a potential of 400 GW per year.

Switzerland

- 21% of total energy is generated by renewable sources.
- Investment of USD 221.2 million per year through 2035 in renewable energy, about 0.5% of the 2019 GDP.

Denmark

- 47% of the electricity consumed in the country is obtained from wind energy.
- Cost reduction and improvement of offshore wind turbine technology.

...as well as a clear regulatory framework that encourages investment in the sector and penalizes the carbon footprint

Uruguay

- 97% of electricity is generated from renewable sources.
- The country ranks fourth in the world in wind and photovoltaic power generation.
- Promotion by the government of renewable energy investment policies for companies.

Chile

- Renewable sources account for 48.3% of installed capacity.
- In 2020, an investment of USD 9 billion was made in generation and of USD 1 billion in transmission and electrical substations, together representing close to 3% of the GDP in 2019.

Argentina

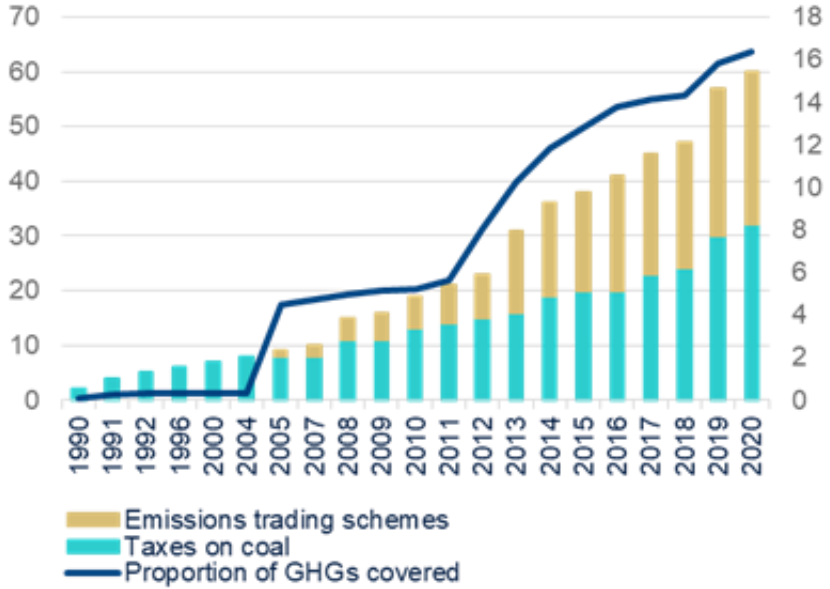
- Renewable energies added more than 1830 MW of power during the last two years.
- It has the largest solar park in Latin America with 300 MW of power.

Brazil

- Country with one of the cleanest energy matrices in the world, according to IEA.
- In 2019, it was the country that installed the most hydroelectric power worldwide, generating 4919 MW, representing 83.3% of the domestic electricity supply.

The market, by itself, is not able to internalize the negative exogeneity of GHG* emissions

EMISSIONS PENALTY INITIATIVES
(NUMBER OF INITIATIVES IMPLEMENTED TO DATE, %)

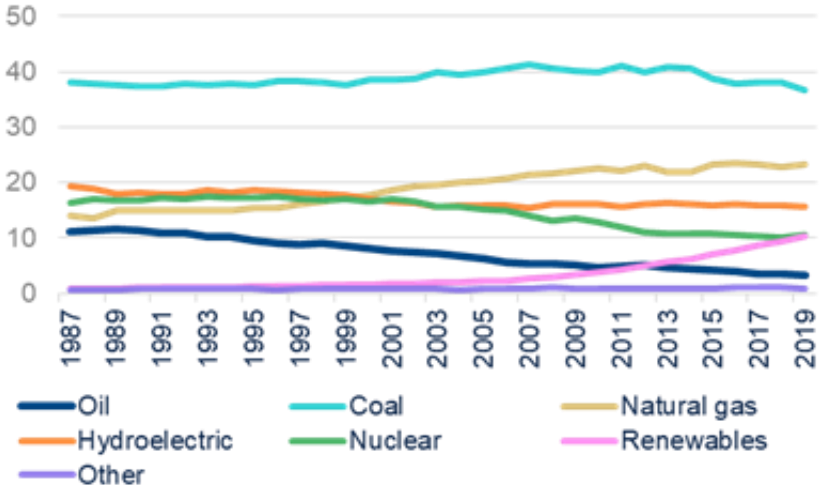


- There are currently 60 initiatives in operation worldwide and 4 to be implemented that assign a price to emissions and cover a total of 45 national jurisdictions and 33 sub-national jurisdictions.
- These initiatives cover about 16% of total global emissions and are expected to reach 22% coverage with the entry into operation of the last four. And, although their coverage has almost doubled in the last 10 years, it is still very low.

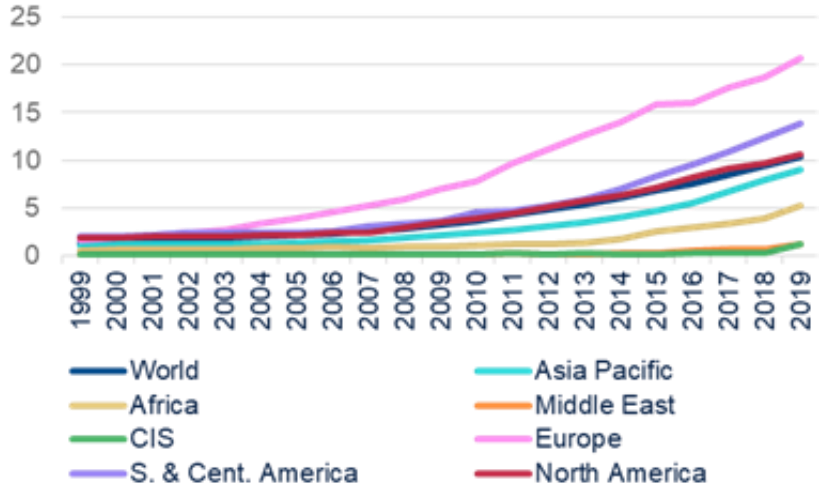
*GHG: Greenhouse gases.
Source: BBVA Research based on data from the World Bank.

We are seeing a shift to cleaner sources, with good performance in the region, but with major challenges ahead

ELECTRICITY GENERATION BY SOURCE
(% OF TOTAL)



RENEWABLE SOURCES* IN THE ENERGY MATRIX
(% OF TOTAL)



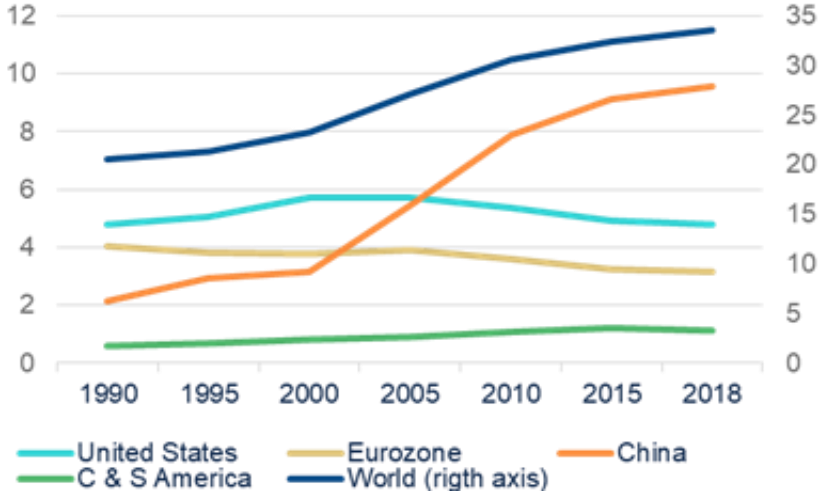
*Renewable sources do not include hydropower.
Source: BBVA Research based on data from BP.

Although coal still accounts for about 38% of the world's energy generation, renewable sources peaked at 10.4%.

This in turn has represented a slowdown in the growth of carbon emissions in the world, with the exception of China

CO_2 EMISSIONS *PER CAPITA* IN THE WORLD AND SELECTED REGIONS

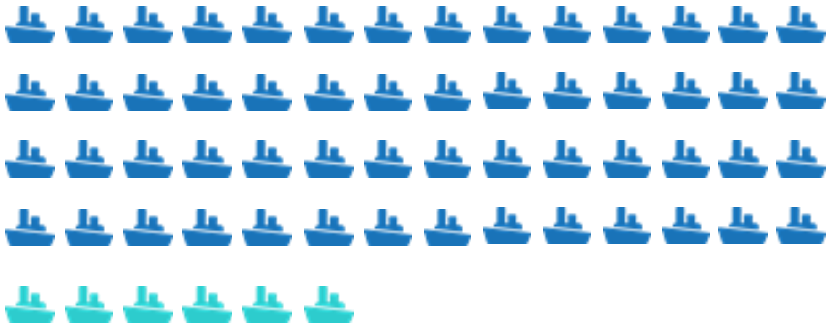
(THOUSANDS OF MT[G])



*Oxfam, 2019

Source: BBVA Research based on data from IEA[G].

China is still facing a huge challenge in energy transition. Its carbon emissions account for **28.6%** of global emissions.

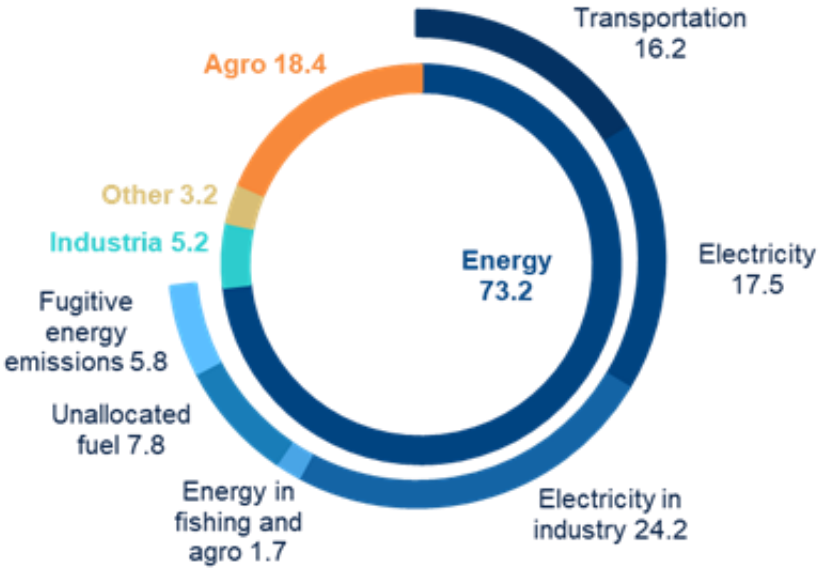


South America: the weight of its CO_2 emissions is equivalent to **51** loaded Chinese ships, while all of South America is equivalent to **6.**

And it shows regional concentration, because while the poorest half of the world's population generates 10% of the world's emissions attributed to consumption, the wealthiest 10% generates 50% of these emissions*

GHG emissions from electric power now account for just over 40% of total emissions

GLOBAL CO2 EMISSIONS BY SECTOR*
(THOUSANDS OF MTG)



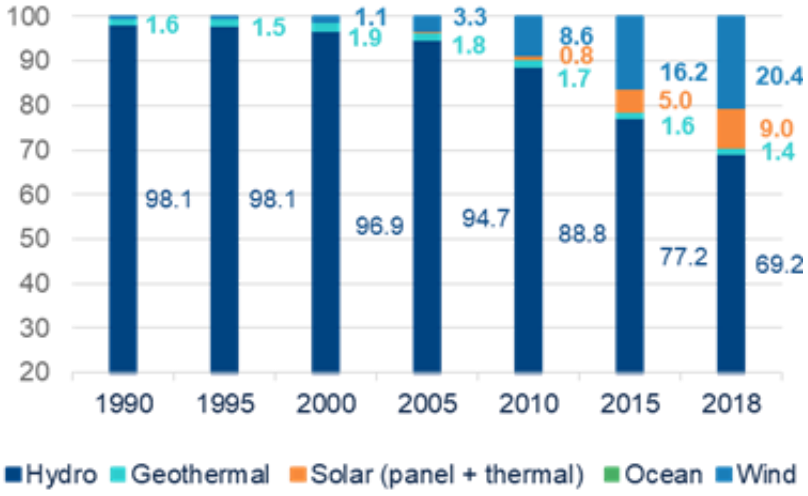
- Energy accounts for 73% of the world's GHG[G] emissions due to its composition of sources. This percentage drops to about 40% when we look only at electricity.
- However, in the case of South America, this picture is somewhat different because the composition of the energy matrix is highly dependent on water; for this reason, emissions are lower in the electricity sector and are rather concentrated in other sectors such as agriculture (deforestation, crop burning) and transportation.

*Classification based on IPCC[G] methodology.
Source: BBVA Research based on data from Our World in Data.

The renewable energy matrix in Latin America, as well as in Colombia, is not very diverse and is concentrated in water sources

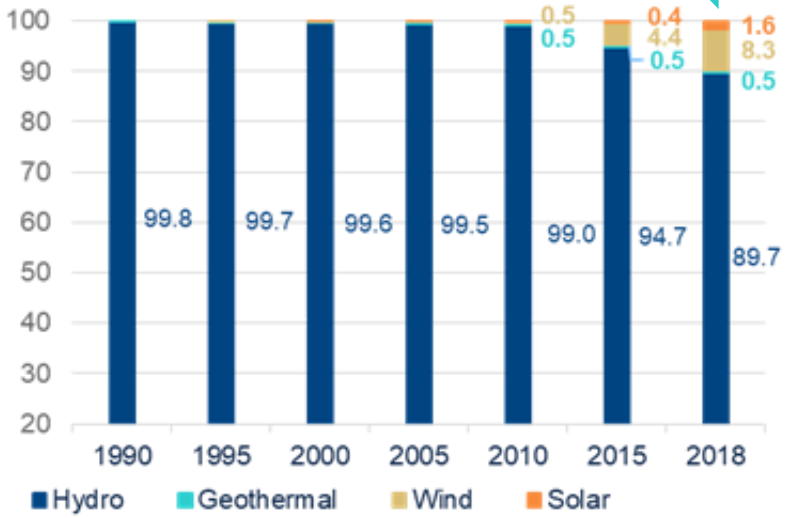
WORLDWIDE ENERGY GENERATION BY RENEWABLE SOURCES
(% OF TOTAL)

+1.4 million GWh of NCRES since 2010



ENERGY GENERATION BY RENEWABLE SOURCES IN CENTRAL AND SOUTH AMERICA
(% OF TOTAL)

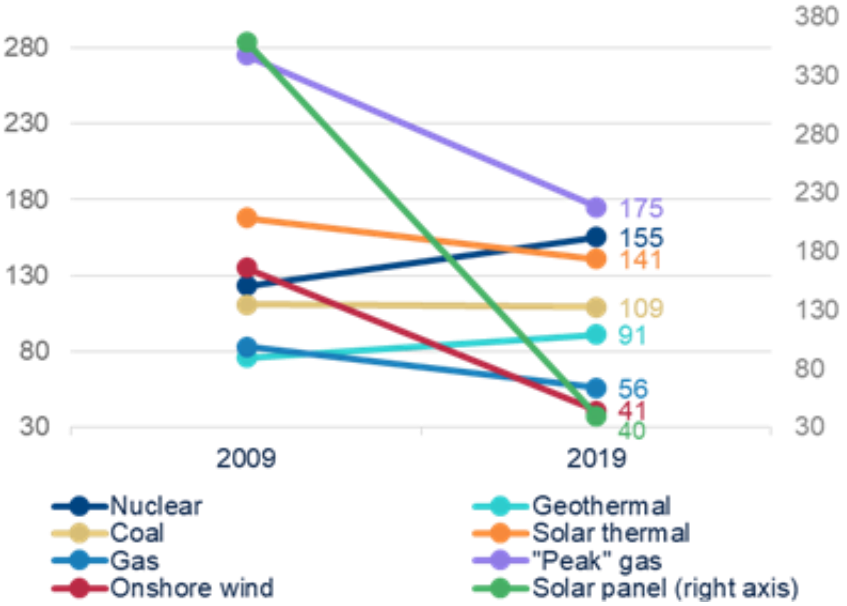
+75 thousand GWh of NCRES since 2010



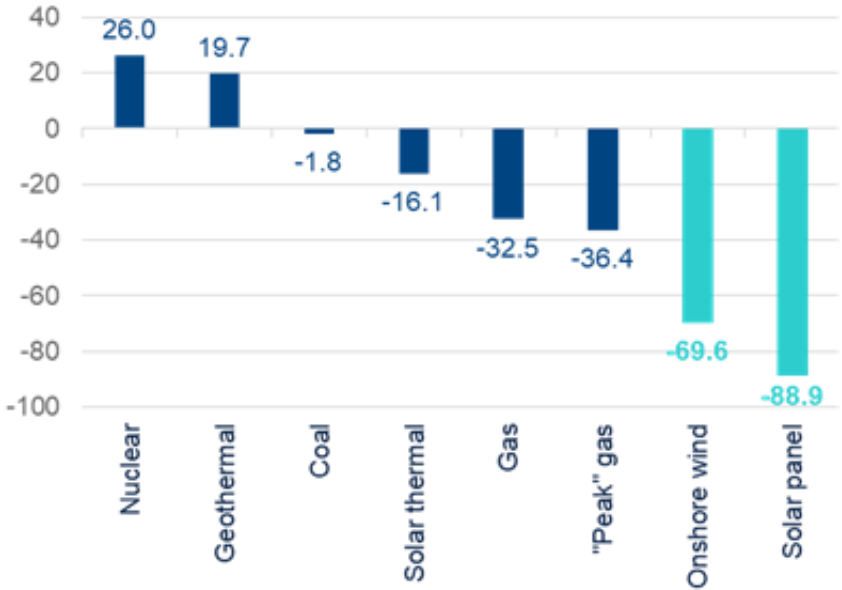
Source: BBVA Research based on data from XM[G] and UPME[G].

The prices of clean energy have been decreasing, creating a favorable environment for the transition toward clean energy

ENERGY PRICE BY SOURCE
(LCOE[G]*, MWH[G])



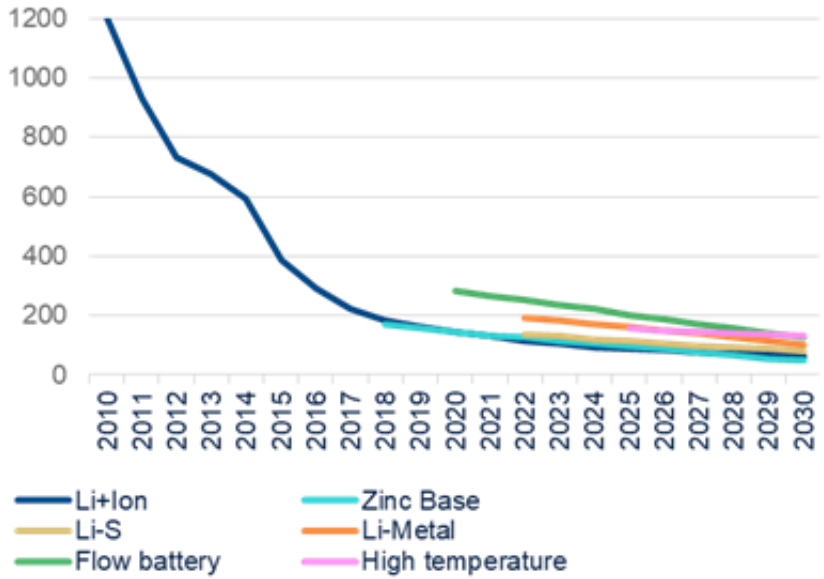
CHANGE IN ENERGY PRICE BY SOURCE
(2009 VS. 2019, %)



*LCOE: Levelized cost of energy.
Source: BBVA Research based on data from Our World in Data.

At the same time, storage costs, which were a major barrier, have also fallen

BATTERY DEVELOPMENT COST
(DOLLARS PER KWH[G])



- Investment in battery research and development for energy storage would reach USD 150 billion by 2023.
- Li-ion battery development costs have fallen by about 90% in the last 10 years.
- In addition, the price of these batteries is expected to continue to fall and encourage the migration to cleaner sources.

Source: BBVA Research based on data from RMI[G].

However, the transition to zero-emission sources remains a challenge in some key sectors of the world economy

HARD-TO-ABATE SECTORS


Aviation


Aluminum


Steel


Cement


Chemicals


Cargo transportation

- The elimination of emissions in these sectors is a global challenge for different reasons. Some of these consume a large amount of energy, which makes the transition to renewable sources impossible. In other cases, the costs of cleaner energy are very high and limit the field of action, especially in countries with fewer resources.

- Progress in these sectors is key to compliance with international environmental agreements, as nearly 20% of the world's GHG emissions are generated in the aforementioned sectors.

Source: BBVA Research based on data from RMI[G].

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02

Energy transition

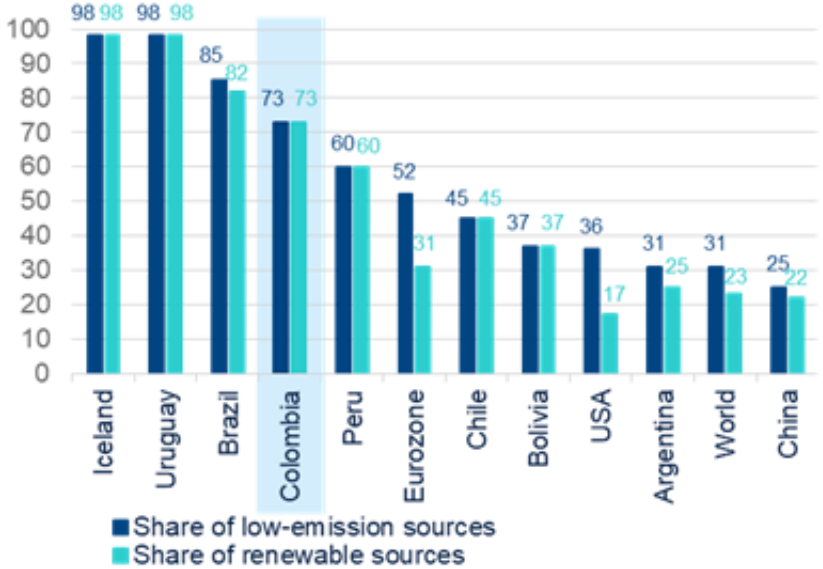
supported by Non-Conventional Renewable Energies

In Colombia

Creando Oportunidades

Colombia is among the countries with the highest share of renewable energy, but non-conventional energy still has a low share

SHARE OF RENEWABLE AND LOW-EMISSION SOURCES IN THE ENERGY MATRIX
(% OF TOTAL ENERGY MATRIX)



- The share of low-emission energy sources, such as nuclear energy, is significant in the US and Europe, which creates a gap when analyzing the share of renewable vs. low-emission energy.
- In the case of Colombia, both renewable and low-emission sources are mostly from the hydropower component, as in Uruguay and Brazil.

Source: BBVA Research based on data from IEA[G].

However, Colombia is already on the road to energy transition and diversification of the energy matrix

1st NCRE[G]* auction

Awarded
1298 MW[G]

8
Projects


5
wind

3
solar

Of the energy matrix in 2020 **7%**

Average price **USD 95**

Estimated investment **USD 2 billion**

Upcoming auction (Jun-2021)

Award objective
5000 MW[G]

Project start-up

2022

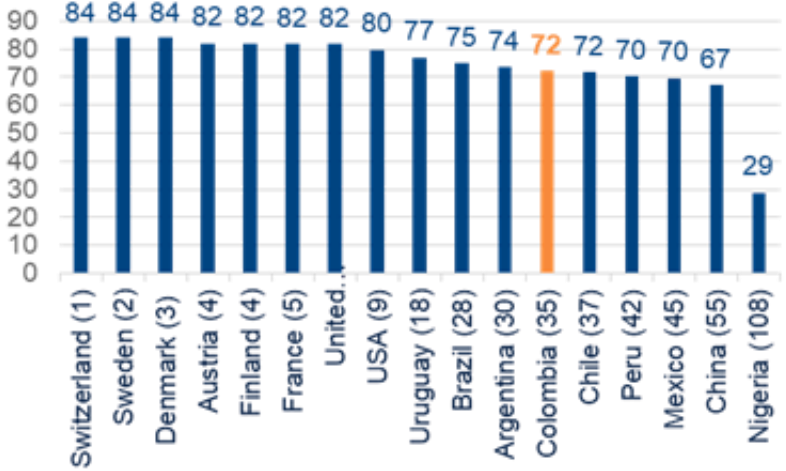
Estimated investment **USD 6 billion**

*Non-Conventional Renewable Energies.
Source: BBVA Research based on data from UPME[G].

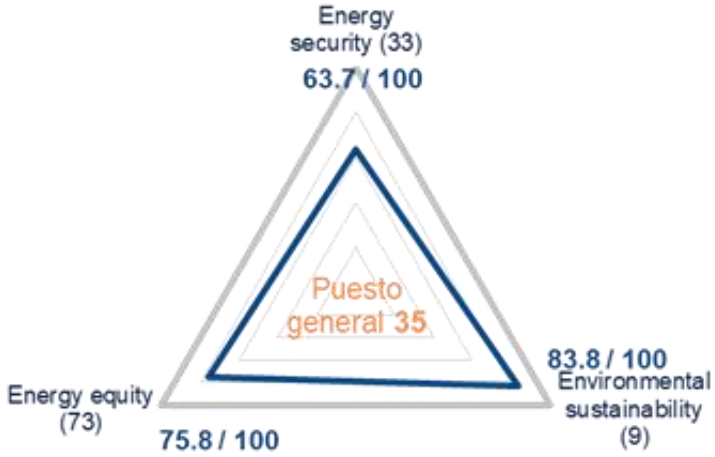
The government's goal is for between 12% and 14% of the energy matrix to come from non-conventional renewable energies by 2022.

This has led us to climb nine places in the energy transition ranking* and to obtain ninth place in the sustainability axis

ENERGY TRANSITION RANKING
(GLOBAL SCORE, POSITION OCCUPIED IN PARENTHESES)



WEC RANKING COMPONENTS FOR COLOMBIA
(SCORE ACCORDING TO AXIS, POSITION OCCUPIED IN PARENTHESES)



*World Energy Council (WEC) ranking.
Source: BBVA Research based on data from WEC[G].

The WEC has highlighted the inclusion of NCRES in the matrix, however, the country still faces a significant challenge in the area of energy equity, specifically in the aspects of population access to electricity and gasoline and diesel prices.

Colombia has great potential to exploit NCRES, as the geographic and climatic conditions allow it

Wind

Potential installed capacity of more than **30 MW**[G] on the North Coast and in Santanderes, Boyacá, Risaralda, Tolima, Huila, Valle del Cauca.
Wind speeds close to 9 m/s.

Geothermal

Low-cost exploitation sites such as the Nevado del Ruiz area and the region of influence of the Chiles, Cerro Negro and Azufral volcanoes. Few exploratory analyses have been carried out and there is no regulatory framework in this area.

Solar

Average irradiation of **4.5 kWh/m2/d**[G]**,** exceeding the world average of 3.9 and the average of Germany (3.0), the No. 1 country in the use of this source. We have potential regions on the Atlantic Coast and in Arauca, Casanare, Vichada and Meta, where irradiations of **6.0 kWh/m2/d**[G] can be reached.

Biomass

We have eight potential agricultural products for energy production.
Their waste could potentially generate **96 kGW**[G] of energy per year, accounting for 0.6% of 2019 energy demand.

NCRE[G] in NIZs[G]*

Opportunity for the deployment of the aforementioned NCRES in small developments for areas that currently base their energy consumption on fossil fuels.

*NIZs: Non-interconnected zones.
Source: BBVA Research based on data from [UPME]G.

In addition, tax benefits and a regulatory framework are already being introduced to encourage investment in this sector

Law 1715 of 2014

Objective

Promote the development and use of NCRES in the National Energy System, their participation in Non-Interconnected Zones (NIZs) and in other energy uses as a necessary means for sustainable economic development, the reduction of GHG emissions and energy supply security.

CREG Resolution 030 of 2018

Objective

To regulate the activities of small-scale electricity generation[G]* and distributed generation[G] by means of NCRES. This resolution defines the rules that allow users to connect to the Network Operator (NO), either as self-generators or distributed generators.

Tax benefits

Benefits

- Special deduction in income tax determination
- Accelerated depreciation
- Exclusion of goods and services from VAT
- Exemption from customs duties

*Small-scale self-generators: capacity less than 1000 MW.
Source: BBVA Research based on data from UPME[G].

However, there are still some barriers that impede the development of new energy sources and require more attention from the State

	Sale of surpluses	Risks	Infrastructure
Definition	In Colombia, the sale of surplus energy generation to the NIS[G] is not yet fully regulated.	The exploration stages in NCRE[G] are usually high cost and high risk for investors.	The NIS[G] transmission and distribution network is still insufficient to connect the potential areas for the development of NCRE[G].
Action	Regulation is needed in this area to generate incentives for NCRE[G] projects.	The government could support this part of technology development.	An expansion of the transmission network is required to transport energy from these areas to the rest of the country.

Source: BBVA Research based on data from UPME[G].

Finally, it's important to recognize that energy sustainability must go hand in hand with new technological and scientific developments

Key technological approaches

CCUS[G]

- The capture of carbon dioxide from fuel combustion or industrial processes, and its use as a resource to create valuable products or services.
- Its role is changing over time, starting with the decarbonization of heavy industries and migrating toward the elimination of carbon from the atmosphere.
- Since 2010, large-scale installations of CCUS[G] have doubled and investment plans in this area have been expanded, mainly in the United States and Europe.

Electrification of sectors

- A significant increase in electricity demand is expected due to the transition of some sectors to this cleaner energy.
- Investment in the development of technologies is essential in order to reduce the cost of renewable energy storage batteries.

Hydrogen and related fuels

- The formation of a fuel cell that combines hydrogen and oxygen to produce electricity, heat and water.
- A promising energy source for residences and electric vehicle motors.
- Hydrogen is found in abundance throughout the world in different organic compounds (gas, water, methanol).
- 2019 saw a boom in the use of this technology, although more associated with generation using high-emission fuels. High exploitation potential in LatAm.

Bioenergy

- A renewable energy that comes from biological sources such as animals and plants. Used to produce fuels, electric energy, heating, among others.
- A technology concentrated in a few countries and with not much presence in LatAm.
- The cost of this technology is still high, above solar and wind energy, and has not fallen at the same rate as other technologies.

Source: BBVA Research based on data from IEA[G].

These technologies are expected to nearly halve emissions by 2070 under a scenario in which global environmental policies are maintained.

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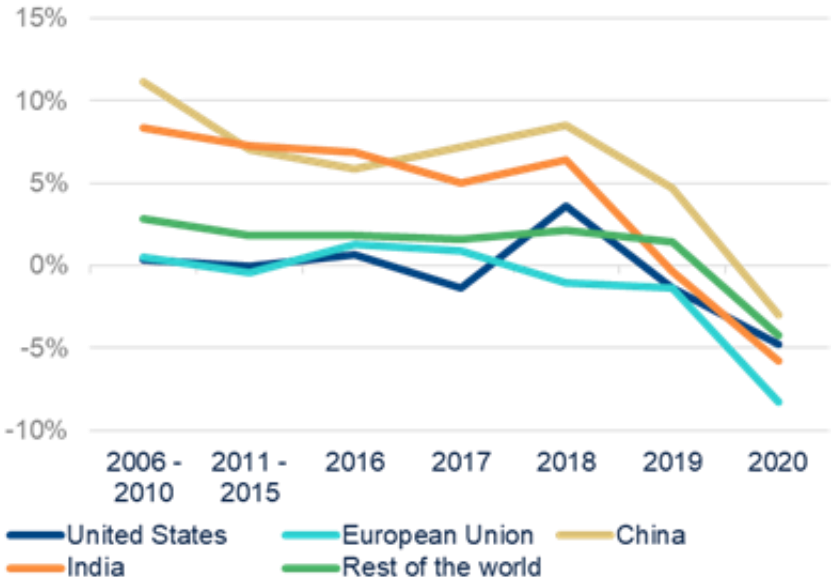
03

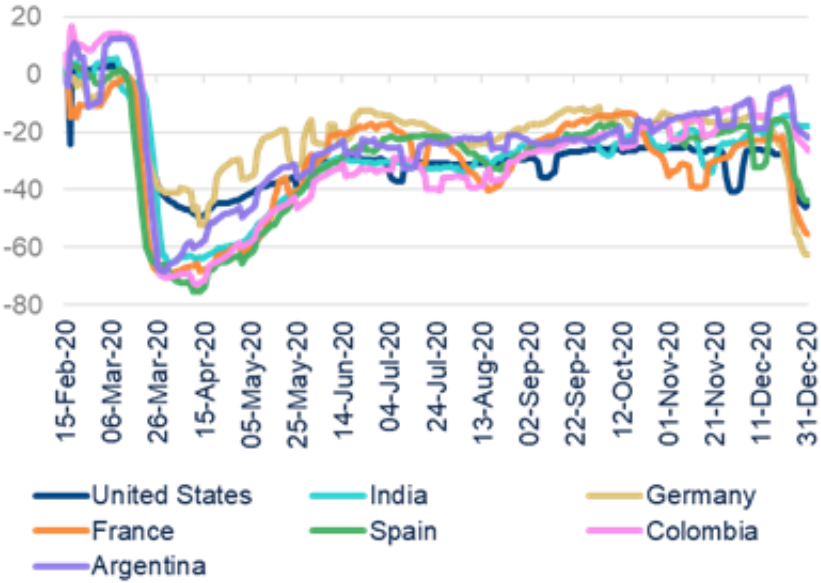
Impact of Covid-19 on the energy transition

Covid-19 significantly affected economic and social dynamics, impacting energy demand worldwide

ELECTRICITY DEMAND BY REGION
(ANNUAL AVERAGE CHANGE, %)



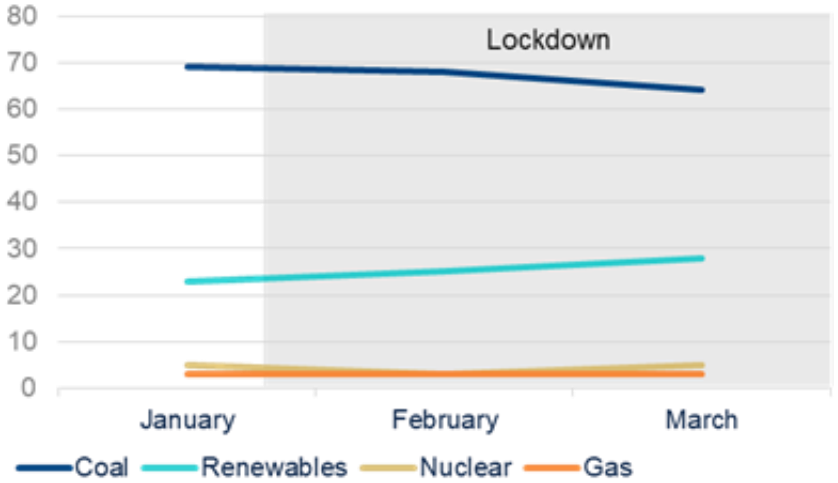
MOBILITY TO WORKPLACES
(CHANGE FROM FEBRUARY 14, 2020, 7-DAY MOVING AVG.)



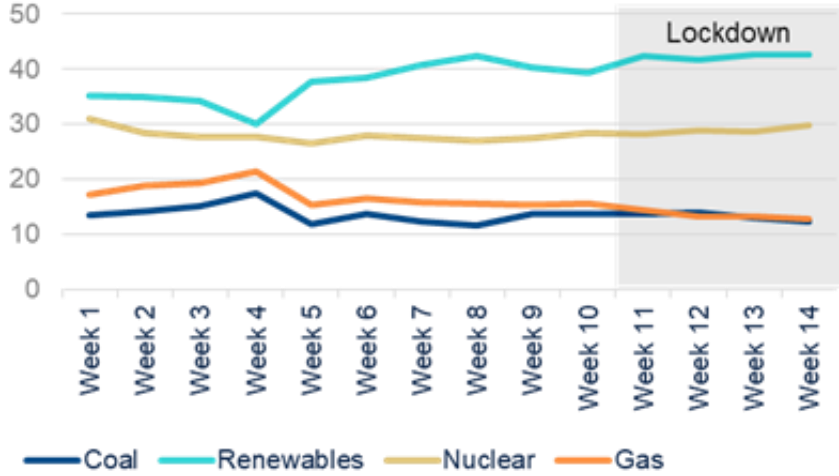
Source: BBVA Research based on data from Google and WEC[G].

Also leading to changes in the composition of demand and its generation sources: more residential and more renewable

ENERGY GENERATION COMPOSITION IN CHINA
(% OF TOTAL)



ENERGY GENERATION COMPOSITION IN THE EU
(% OF TOTAL)

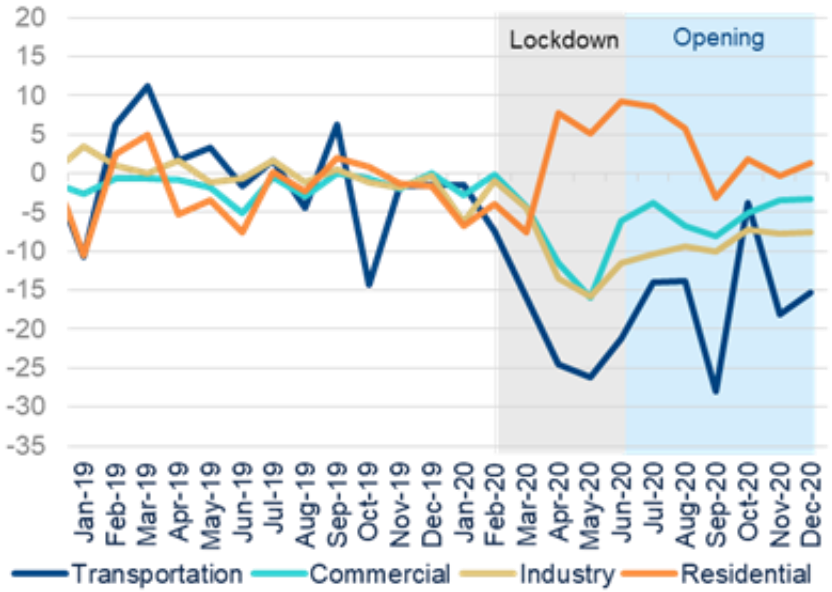


Source: BBVA Research based on data from Energy Review 2020.

The drop in energy demand had a favorable impact on the share of renewables in final energy consumption due to a slowdown in demand from segments that are more fossil fuel-intensive.

New ways of working and longer stays at home have increased the energy consumption of the residential segment

ELECTRICITY DEMAND BY SECTOR IN THE UNITED STATES
(ANNUAL CHANGE, %)



- In most countries of the world, there was a significant increase in electricity consumption in the residential sector while, at the same time, there were sharp declines in industrial and commercial segments due to the cessation of operations as a result of the lockdown policies adopted by governments.

- A large proportion of employees moved to home-based work, increasing the use of household appliances and computer equipment that depend directly on electric power. As the economy opened up, residential demand moderated, giving way to increased industrial and commercial demand.

Source: BBVA Research based on EIA data.

The effects of Covid-19 were also seen on operators, generators and even on the execution of projects

Lockdown

Lower energy demand

Exchange rate devaluation

Lower income of households

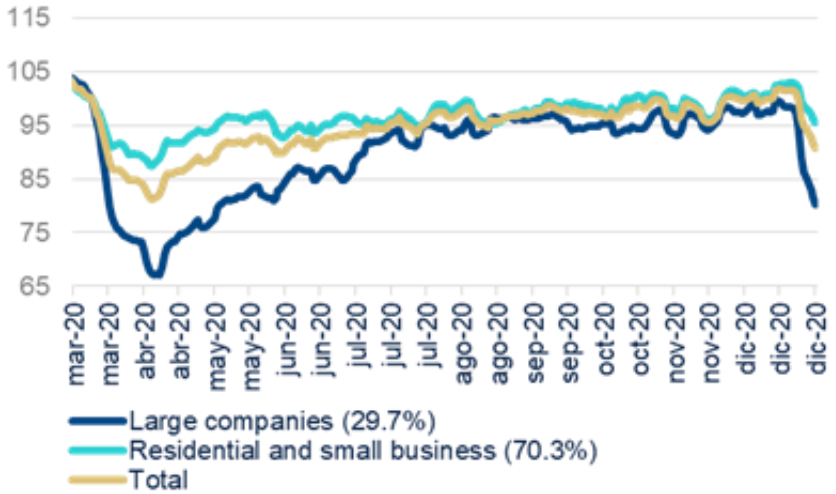
Relief, subsidies, payment terms

Lower revenue for operators

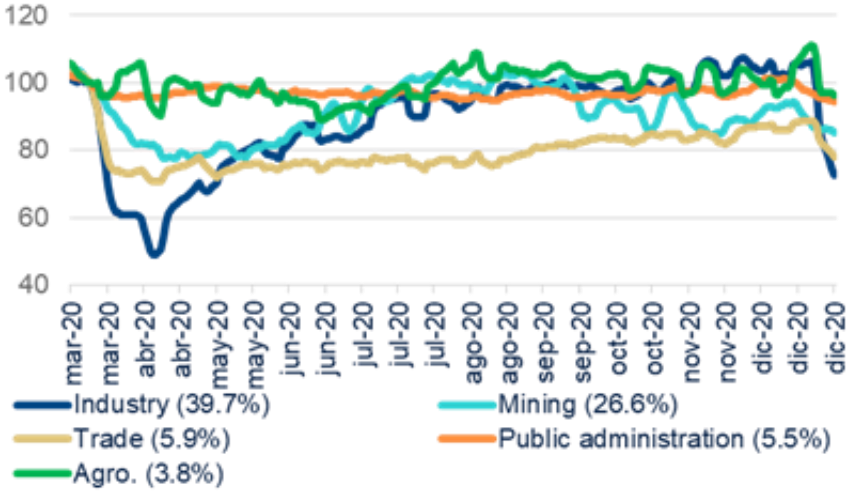
Delays or postponements of new generation projects

In Colombia, the energy demand of large companies dropped to 65% of what it was before the pandemic, with a greater effect on industry

ELECTRICITY* DEMAND IN COLOMBIA
(INDEX, MARCH 19, 2020 = 100)



ELECTRICITY DEMAND IN LARGE COMPANIES
(INDEX, MARCH 19, 2020 = 100)

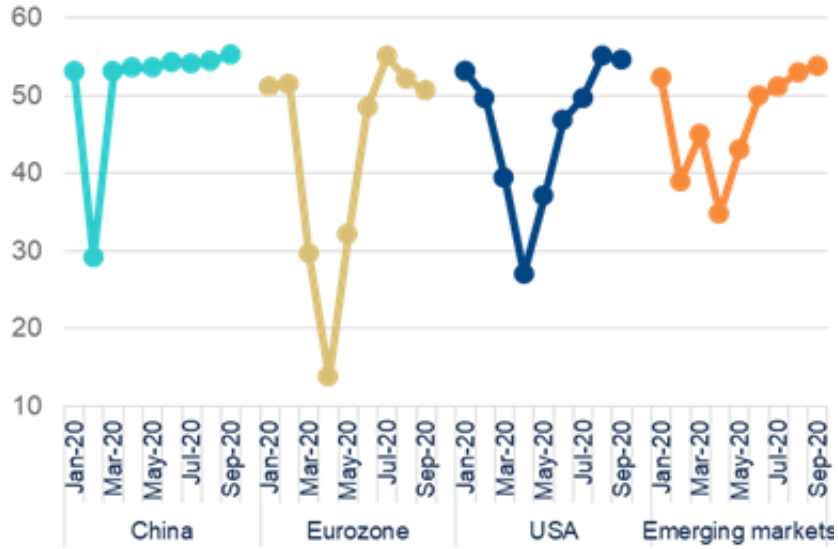


*Large companies correspond to non-regulated demand while regulated demand refers to residential and small businesses.
Source: BBVA Research based on data from XM[G].

Residential electricity demand in Colombia was less impacted, as was the case in the rest of the world; it recovered faster and is already above pre-pandemic levels.

The new composition of the energy matrix will depend on the type of economy and its recovery, as well as on the available technology

PMI INDICATORS
(MORE THAN 50: EXPANSION; LESS THAN 50: CONTRACTION)



- Covid-19 had a negative impact on renewable energy projects under development, with delays and disruptions in the necessary supply chains. However, once the lockdown measures were relaxed, a rapid reactivation was observed in most developed countries, as well as a special push from China, which completed hydropower projects in the first half of 2020.

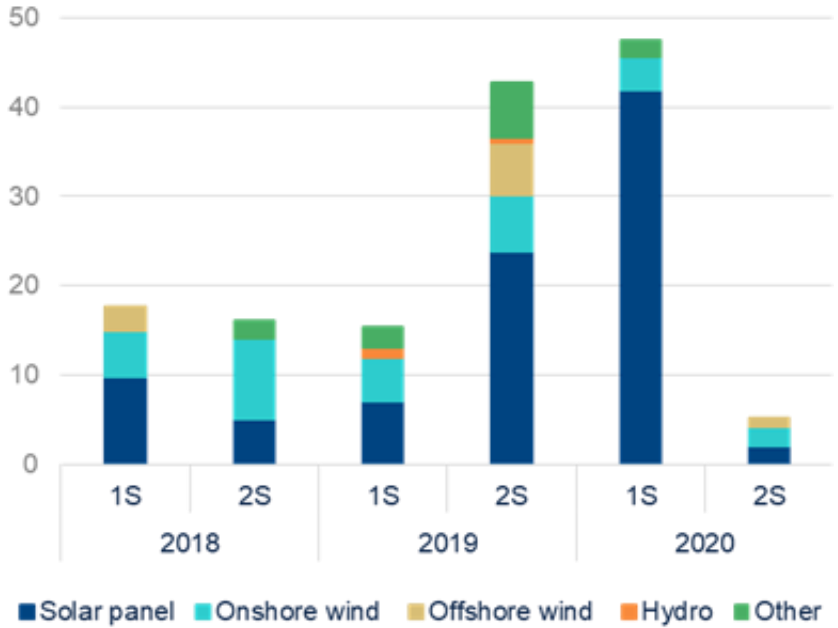
- In turn, a greater backlog of projects was seen in countries where companies are less financially healthy and already had financial problems prior to the pandemic, especially in emerging countries, such as India.

Source: BBVA Research based on data from Haver.

Some countries suffered more than others, but in general, the robust policies defined previously were key to sustaining the sector

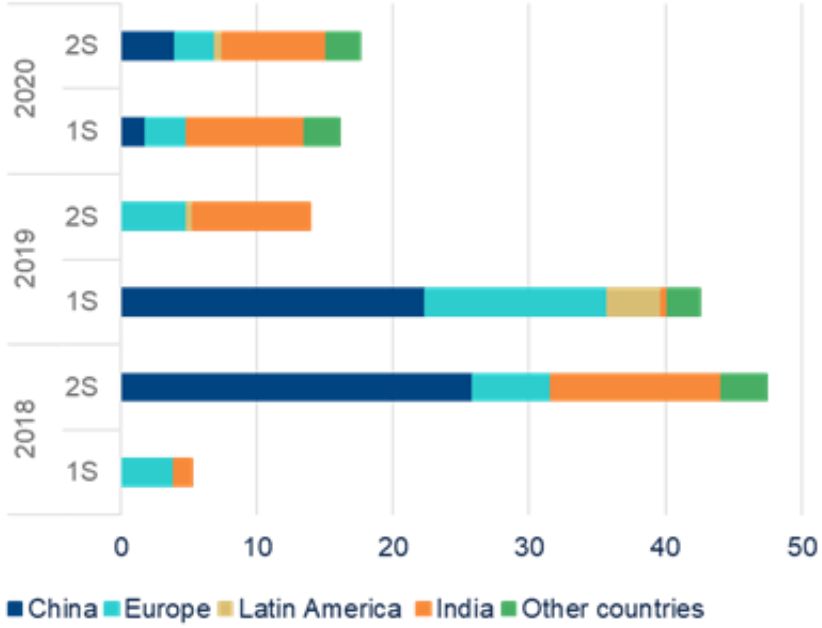
RESULTS OF RENEWABLE ELECTRICITY AUCTIONS BY SOURCE TYPE*

(GW)



RESULTS OF RENEWABLE ELECTRICITY AUCTIONS BY REGION*

(GW)



Source: BBVA Research based on data from IEA[G].

Some lessons learned from Covid-19 in the energy sector in the short term...

Sustainability of renewable sources

Non-conventional renewable energies have proven to be one of the most reliable sources. Their generation was not affected by supply and demand factors. In terms of price, they are more stable than other types of energy and this generates greater energy security.

Change in energy dynamics

The pandemic slowed the growth of energy demand throughout the world. Reduced economic activity and changing social dynamics reduced energy consumption and kept it there for a while longer.

Energy security

The pandemic made clear the importance of the population's access to electricity for production, communication, educational and health purposes, exposing the inability of many governments to provide this service to their entire population.

Time for developments

There was a gain in time that allowed an increase in the learning curve of NCRES and battery development. This will be decisive in gaining greater efficiency and reducing the costs associated with these new technologies.

....however, specific actions by governments focused on environmental issues are required in order to ensure that the gains achieved will be exploited and will last in the long term

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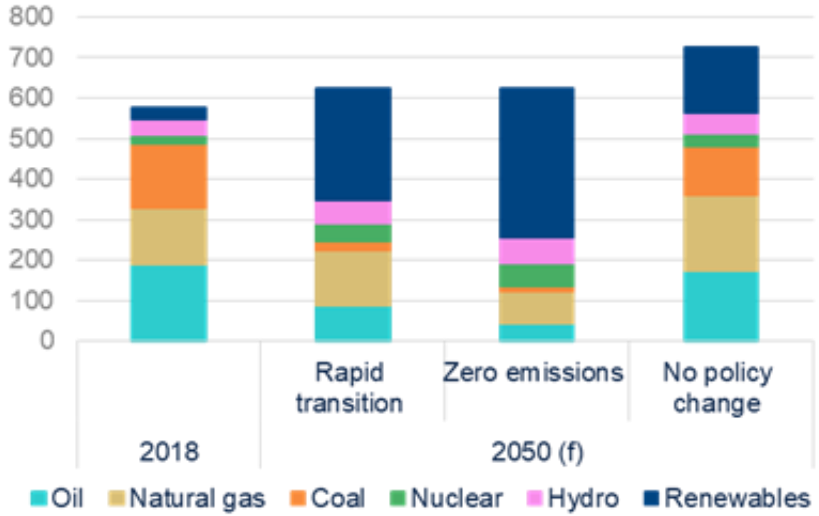
04

Where are we headed? Challenges and opportunities

World energy demand projections incorporate scenarios involving compliance with global environmental policies

WORLD PRIMARY ENERGY DEMAND BY SOURCE
(EJ[G])



Source: BBVA Research based on data from BP.

Rapid transition scenario

A series of more specialized policies in sectors that significantly reduce GHG emissions, achieving the objectives set out in the Paris Agreement.

Zero emissions scenario (most extreme)

The policies of the rapid transition scenario are reinforced and include changes in society's behavior and preferences, achieving lower emissions and reducing the temperature increase below that established in the Paris Agreement.

Scenario with no policy changes

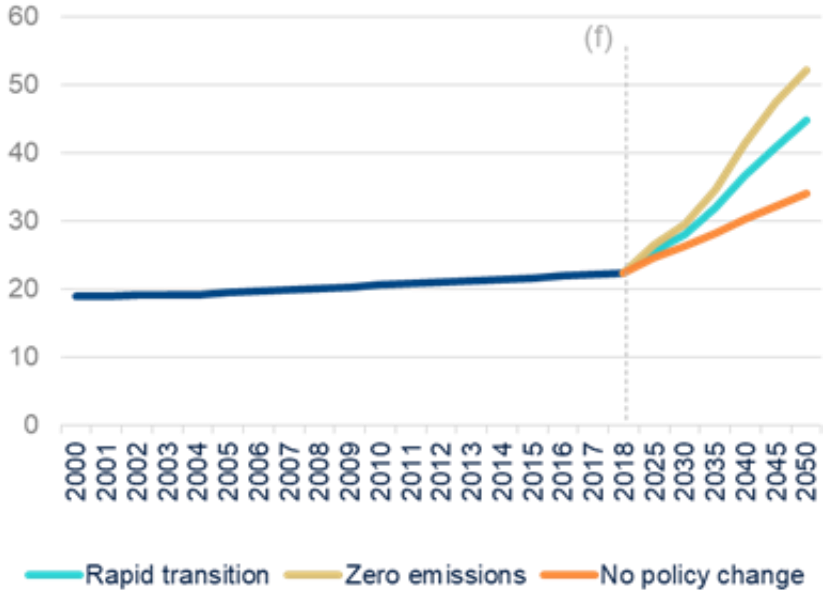
Current policies and technological developments are maintained, with a rate of evolution similar to that observed. The reduction in emissions is lower in this scenario, but a reduction is still observed.

Although with a high degree of uncertainty regarding the fulfillment of the agreements and the new generation of commitments and policies by governments.

In which the role of electricity will be fundamental for the world's energy transition

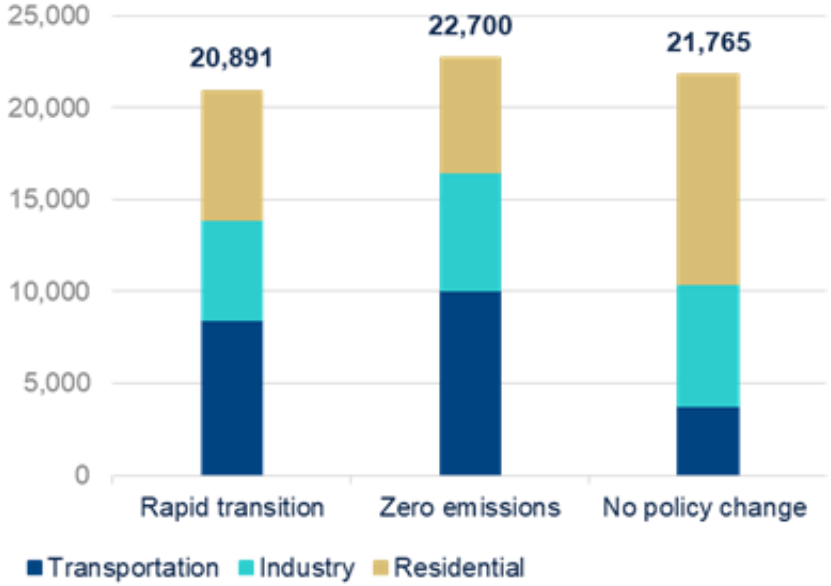
SHARE OF ELECTRICITY IN FINAL WORLD ENERGY CONSUMPTION

(% OF TOTAL ENERGY CONSUMPTION)



CHANGE IN ELECTRICITY DEMAND BY SECTOR 2018–2050

(TWH[G])



Source: BBVA Research based on data from BP.

The framework for action in Colombia for the coming years is detailed in the *Plan Energético Nacional* (National Energy Plan, or PEN)

The PEN seeks to meet the country's energy requirements, within the framework of a global energy transformation, marked by greater sensitivity to the environment, an emergence of new demands from communities, higher levels of economic growth, technological development and commitments to mitigate the impacts of climate change.

Objectives

- Security of energy supply and diversification of the energy matrix.
- Energy as axis of economic development and prosperity.
- Environmental management of the energy sector.
- Ensuring coverage of energy services and products with territorial development and inclusion.
- Energy efficiency.
- Regional energy integration.
- Enabling environment for the implementation of the PEN[G], 2020–2050.

Source: BBVA Research based on data from UPME[G].

Pre-pandemic PEN[G] projections envisioned a more robust energy demand driven by increased use of NCRE[G]

Scenario 266

- Energy demand of 2099 PJ[G] by 2050.
- 30% emissions reduction by 2050.
- Exceed climate change targets.
- Improved energy efficiency.
- Electric mobility law goals are achieved.
- Firewood disappears from urban areas.
- Incorporation of cleaner and more efficient technologies and adoption of best practices in energy consumption.

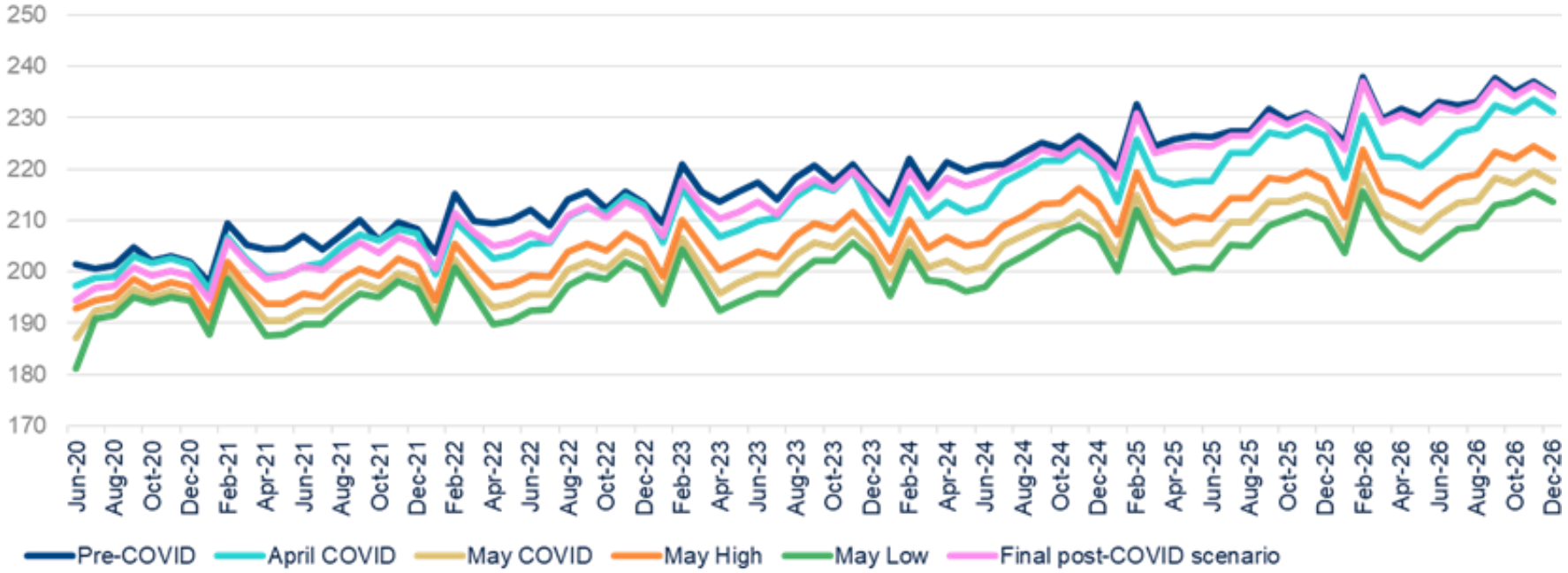
New commitments

- Energy demand of 1785 PJ[G] by 2050.
- 48% emissions reduction by 2050.
- Far exceeds climate change targets.
- Theoretical levels of energy efficiency are achieved.
- Electric mobility law goals are significantly exceeded.
- Pushing the energy system to the limit by seeking electricity as the main source.

Source: BBVA Research based on data from UPME[G].

However, the pandemic led to reconsidering previous projections and adopting a new energy demand scenario

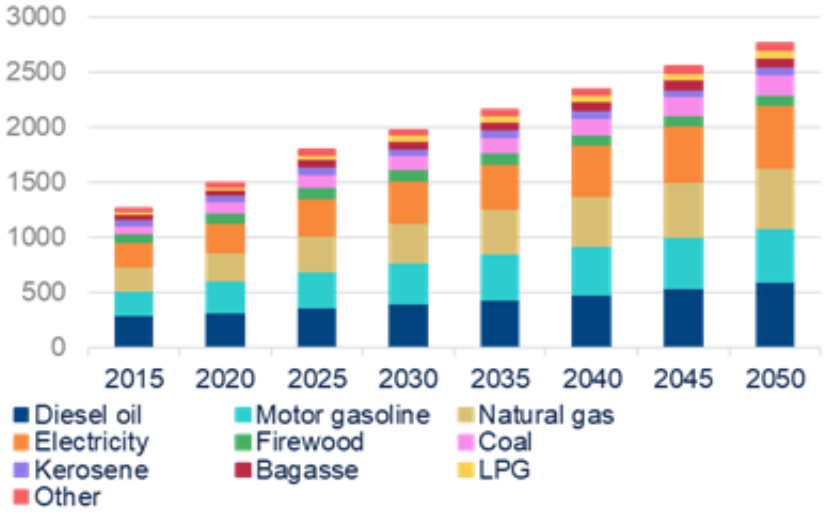
ELECTRICITY DEMAND PROJECTION
(GWH[G]-DAY)



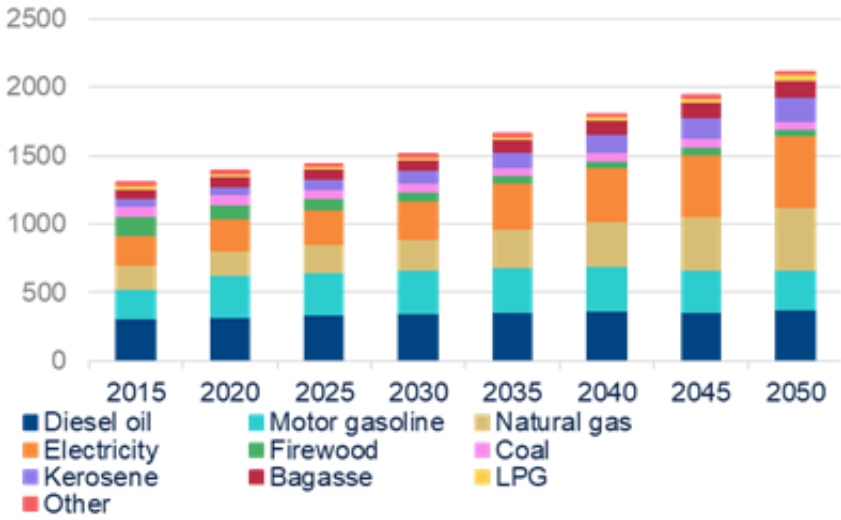
Source: BBVA Research based on data from UPME[G].

Although the demand for electricity continues to grow due to the substitution of fossil fuels in sectors such as industry and transportation

FINAL ENERGY CONSUMPTION BASELINE SCENARIO
(PJ[G])



CONSUMPTION OF ENERGY IN SCENARIO 266
(PJ[G])

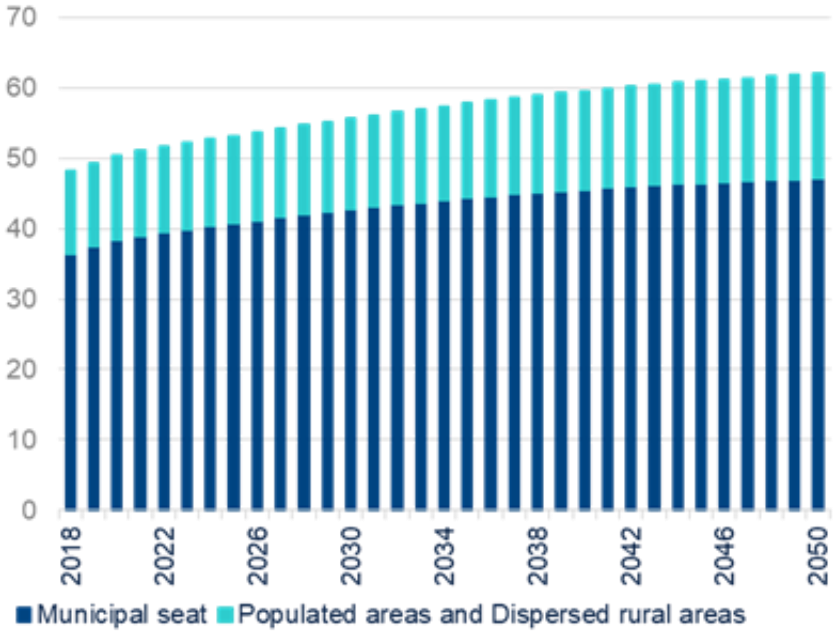


Source: BBVA Research based on data from UPME[G].

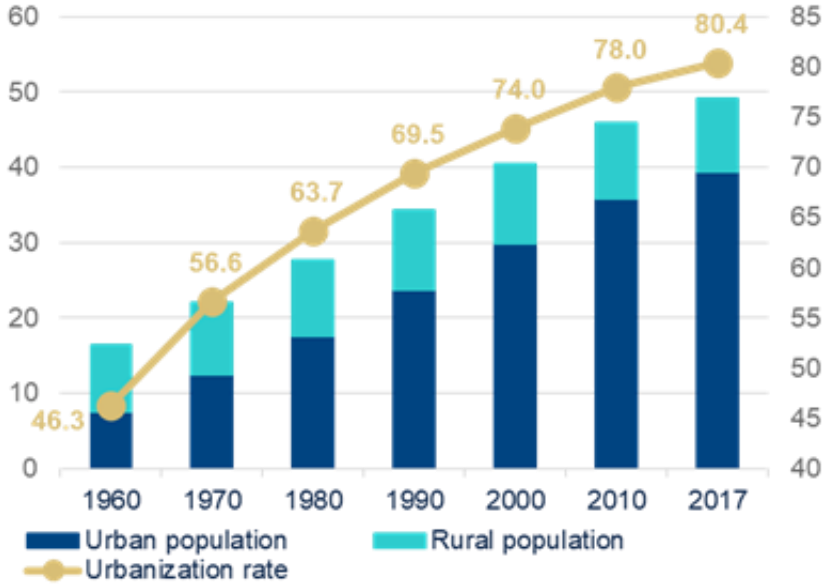
Electricity consumption in the Colombian economy will increase 1.36 times by 2030, supporting the decarbonization of other sectors.

As well as by the estimated population growth and a higher rate of urbanization

POPULATION PROJECTIONS
(MILLIONS OF PEOPLE)



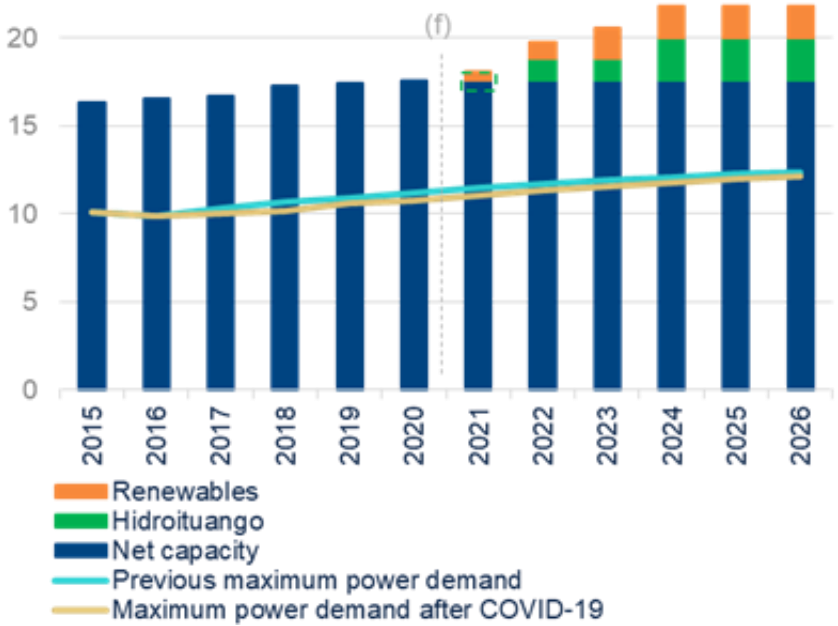
URBANIZATION RATE
(% OF THE POPULATION)



Source: BBVA Research based on data from DANE and Celade.

By 2021–2022, NCRES-based projects would provide peace of mind in the energy sector. Going forward, there is greater uncertainty

NET GENERATION CAPACITY AND PROJECTIONS
(GW)



Source: BBVA Research based on data from UPME[G].

- The country's net generation capacity expansion plans are based mainly on the commissioning of the Hidroituango plant, as well as on the projects awarded in the renewable auctions.
- The CREG (*Comisión de Regulación de Energía y Gas* – Energy and Gas Regulation Commission) is also analyzing a regulatory change that would allow operators with projects that are more than 80% complete and that have Firm Energy Obligations (FEO) to start operations without having fully completed the work. This resolution would allow both Hidroituango and some renewable energy projects to begin operations in 2021 and somehow cover Hidroituango if it were not to be commissioned that year.
- On the other hand, the drop in energy demand due to Covid-19 gave some respite to the system, especially in the short term, with lower expected energy and power demand.

Hidroituango would be a key player in reducing risks on the country's energy sustainability front

WHY IS THIS PROJECT IMPORTANT?

The Ituango hydroelectric plant is expected to have an installed capacity of 2400 MWh, being the largest in the country and increasing the total capacity by about 15%, with an estimated investment of 11.4 billion pesos.

WHEN WILL IT BEGIN OPERATIONS?

Initially, 1200 MW were expected to enter into operation in 2021, but this was postponed to 2022 due to some works delays.

RISKS

Additional postponements of entry into operation.
New environmental disasters with strong impacts on the works.

CAN ENERGY DEMAND BE MET WITHOUT HIDROITUANGO?

At the renewables auction held in 2019, installed capacity was awarded that would enter into operation in 2021 and would cover the generation of Hidroituango for that year.

On the other hand, the drop in energy demand generated by Covid-19 allowed for a later commissioning of Hidroituango, reducing the system's generation needs.

Finally, the new renewables auction will also be critical to cover potential project backlogs in 2022. The awarded projects are expected to begin operations that year.

And, in addition to generation, the Colombian electric energy system has major challenges ahead

Interconnectivity with the region

LatAm does not have an interconnected energy system, which prevents it from trading with peers in the region, as is the case in the European Union, and limits business opportunities that could bring great benefits to those involved.

Expand coverage and access

Access to the energy service is still very poor in the southeastern region of the country. This is one of the greatest challenges not only in terms of expanding the transmission grid, but also in terms of opportunities to exploit non-conventional renewable sources in non-interconnected zones.

Diversification of the matrix

The vulnerability of the Colombian energy sector to climatic anomalies has been highlighted on several occasions. For this reason, the path being taken toward the diversification of the matrix with NCRES is fundamental. However, efforts must be greater and faster.

Greater regulation

Although progress has been made in regulating the sector, there are still large gaps that impede its development. For example, the sale of surpluses from large generators to the National Interconnected System (NIS) still lacks a defined regulatory framework and has already created barriers to greater investments.

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Conclusions

As a reminder…

Current situation

Energy demand grows with the economy and population, as does the accumulation of Greenhouse Gases.

LatAm's energy matrix, as well as Colombia's, is not very diverse and is concentrated in water resources.

In Colombia, there is a high regional concentration in the northwestern area, as well as a high concentration of operators and generation plants.

Impact of Covid-19

Covid-19 had significant impacts on energy demand as well as its sectoral composition. Residential consumption increased while industrial and commercial consumption fell.

The impact of Covid-19 on the energy sector was different among countries. It depended on its reactivation policies, previous economic status and sustainable energy objectives.

Despite the impact on the sector, the pandemic taught some lessons that will be key for the future development of the sector.

Transition based on renewable energies

The world is showing evidence of a transition toward cleaner energy sources with an emphasis on NCRES, mainly solar and wind sources.

The costs of generating and storing energy with NCRES have been decreasing, generating a favorable environment for investment in these sectors.

Colombia is on the road toward the transition and has high potential, but the penetration of these sources is still low.

Where are we headed?

Electricity will be key to the world's energy transition, becoming a major source in sectors such as transportation and industry.

The fall in electricity demand due to the pandemic led to a downward revision of the projections in Colombia.

Colombia faces major challenges to maintain the country's energy sustainability and diversify its energy matrix.

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Appendix

Glossary

- International Energy Agency (IEA): intergovernmental organization that acts as an energy policy advisor.
- Net Effective Capacity: the maximum net power capacity that a plant or generation unit can supply under normal conditions.
- Carbon dioxide (CO2): one of the main causes of the greenhouse effect.
- Energy not dispatched centrally: power generation plants that are not required to declare availability and prices to meet demand; in case they want to declare their availability, they do not have to declare prices. These are plants with an effective capacity of less than 20MV. They are paid at the price established on the stock market or at the price of the contract they are executing.
- Non-Conventional Renewable Energy Sources (NCRES): globally available renewable energy resources that are environmentally sustainable but are not used, or are used marginally and are not widely marketed, such as biomass, small hydropower projects, wind, geothermal, solar and marine. NCRE sources are mainly characterized by the variability of their generation, which is a reflection of the behavior of their primary source, such as irradiation and wind, which depend on the climatic, meteorological and hydrological phenomena of the moment.
- Greenhouse gases (GHG): compounds that are present in the atmosphere in certain concentrations and contribute to increasing the planet's temperature, due to their capacity to absorb and transmit infrared radiation from the earth's surface.
- Distributed generator: legal entity that produces energy close to the consumption centers, is connected to the Local Distribution System (LDS) and has an installed power less than or equal to 0.1 MW.
- Energy intensity: the ratio of energy demand or consumption (E) to gross domestic product. Energy intensity is measured as total primary energy demand per unit of GDP; GDP is measured in terms of ppp.
- Levelized cost of energy (LCOE): captures the cost of the construction of the power plant itself, as well as the ongoing fuel and operating costs of the power plant over its lifetime.
- Firm Energy Obligations (FEO): they correspond to a commitment of the generators backed by generation assets capable of producing firm energy during critical supply conditions.

Glossary

- National Interconnected System (NIS): system composed of the following interconnected elements: generation plants and equipment, the interconnection network, regional and interregional transmission networks, distribution networks and users' electric loads.
- Sea surface temperature (SST): temperature of the surface of the ocean and provides a synoptic view of the ocean and a high frequency of repeat views.
- Mining/Energy planning unit (*Unidad de planeación minero-energética*, or UPME): a special administrative unit, affiliated with the Colombian Ministry of Mining and Energy, in charge of the integral planning of the mining and energy sector.
- Watt (W): a unit of power in the international system that results in the production of 1 joule per second.
- Kilowatt (KW): unit of power equivalent to 1000 watts.
- Kilowatt-hour (kWh): a unit that measures energy consumption in kilowatts per hour.
- Megawatt (MW): a unit of power equivalent to one million watts.
- Gigawatt (GW): a unit of power equivalent to one billion watts.
- Terawatt (TW): a unit of power equivalent to one trillion watts.
- Joule (J): the energy transferred to an object when a force of one newton acts on that object in the direction of the force's motion through a distance of one meter.
- Pentajoule (PJ): five joules.
- Lithium (Li): a chemical element used especially in heat-conducting alloys and electric batteries.
- Megatonne of oil equivalent (Mtoe): its value is equivalent to the energy yield of one metric ton of oil, which varies according to the chemical composition of the oil; a conventional value of 41,868,000,000 J = 11 630 kWh has been taken.
- kWh/m2/d: a unit of measurement that determines the amount of solar energy that a surface area receives in a given amount of time; in this case it is kilowatt hours per square meter per day.
- IPCC: a classification methodology for linking the emission of a greenhouse gas with a particular source to the amount of activity causing the emission.

Disclaimer

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