Box 3
Energy demand as an indicator of industrial activity in Colombia

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The activities and operations of an industrial company rely largely on energy sources such as electricity and gas, in addition to other elements, including raw materials and labor. Manufacturing operations are the primary consumer of multiple energy sources within the industry sector, whereas administrative and operational procedures are secondary consumers. Therefore, the analysis of the industry's energy consumption is a proxy indicator of the real behavior of its activity level, providing noteworthy signals of the sector's economic momentum. For Colombia, the availability and timeliness of electricity and gas information enable the generation of industrial indicators with a less lag compared to official statistics, such as DANE's industrial production index (IPI), thereby facilitating the monitoring of trends and the evolution of the sector in the country.

Energy demand indices (EDI) were constructed to provide timely information reflecting Colombia's industrial activity by combining electricity and gas consumption data into a single monitoring indicator.[1] The geographic and sectoral disaggregation of the data facilitates the construction of indicators with countrywide and department-level coverage. A general indicator of industrial energy demand is calculated for each coverage level, while others focus specifically on manufacturing energy demand (excluding petrochemicals and refineries).

This Box explains the relevance of electricity and gas consumption as inputs to monitor industrial activity, offers an overview of energy components in Colombia, and outlines the methodology and results of the EDI.

1. Electricity and gas are vital inputs to gauge industrial productivity

In many countries, energy consumption is closely related to economic growth, given the broad dependence of all economic activities on this input. This relationship facilitates the construction of timely indicators based on the demand for these inputs to monitor economic activities, particularly in energy-intensive segments, such as the industrial sector. In Colombia, electricity consumption by industry is coupled with the demand for gas. Natural gas usage in the sector has become relevant for both cogeneration and consumption of thermal energy from this resource. There is also greater natural gas consumption for final and transformation uses, with gasification processes observed in specific industries, such as ceramics, chemicals, and paper.

Industrial activity and its extensive demand for these energy inputs reflect positive or negative changes in the growth of this sector in a country. Increases in consumption could indicate industrial expansion, while a decrease could signal a reduction in activity or improvements in energy efficiency. Thus, producing an indicator that jointly assesses industrial demand for these energy inputs helps in monitoring the economic performance of the sector and the country.

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1 The energy demand indices presented in this Box are used internally by the technical staff of *Banco de la República* and assist in analyzing the economic activity situation.

2. Energy components in Colombia

The energy consumed[2] in Colombia is predominantly derived from coal and oil, which together comprised 52% of the country's total energy consumption in 2022,[3] while electricity and natural gas accounted for 32.7% of energy consumed in the same period. Electricity and gas are characterized as cross-cutting inputs in most productive activities, with goods production exhibiting the highest demand. Specifically, the industrial production of goods consumes several energy sources (coal, biomass, oil, and derivatives, among others), with natural gas and electricity accounting for 49.9% of this segment's total energy demand.[4]

According to XM data, the industrial sector is the largest electricity consumer of all economic sectors, followed by mining and coal exploitation. Alternatively, industrial demand for gas represented a little over 26% of this product's total consumption, surpassed by the thermal generation sector, whose gas consumption to produce electricity exceeded 30% of total gas consumption.[5]

Additionally, in recent years, thermal power generation has played a crucial role in Colombia during periods of low rainfall. Since mid-2023, with the start of the most recent El Niño phenomenon, hydraulic power generation decreased while generation from thermal sources, such as gas and coal, gradually increased, ultimately providing over 50% of total energy generated.

3. Energy demand indices (EDIs)

EDIs are constructed from available information on electric power and gas. The data source for electric power in Colombia is XM-Sinergox and, for natural gas, it is the Gestor del Mercado de Gas Natural (Table B3.1).

Table B3.1
IDEM information sources

Type of Energy	Source	Variable	Unit	Frequency
Electricity	XM – Sinergox	Electricity consumption	Gwh	Daily
Natural Gas	Gestor del Mercado de Gas Natural en Colombia	Natural gas consumption	MBTY	Daily

Source: own elaboration.

Energy indicators are released with a lag of ten business days after the end of the month, which is the time required to consolidate the updated daily figures. Consequently, this group of indicators is one of the timeliest in the industry.

The availability of disaggregated information by sector and geographic department allows the construction of different indexes for industrial activity. The Industrial Energy Demand Index (IDEI for its Spanish acronym) approximates industrial production at the national level, and the Departmental Industrial Energy Demand Index (industrial IDED) is an indicator of industrial production at the department level. Additionally, two indicators were devised to monitor manufacturing activity (industrial production without oil refining and petrochemicals): the Manufacturing Energy Demand Index (IDEM for its Spanish acronym) at the national level and the Manufacturing Departmental Energy Demand Index (manufacturing IDED) at the department level. Table B3.2 details the coverage and scope of these indicators.

2 Energy consumption measures the total demand for the various energy sources, such as coal, gas, electricity, oil and biofuels, and waste. All economic sectors are reflected herein, with transportation exhibiting the highest demand, followed by industry.

3 According to data published by the International Energy Agency (IEA)

4 According to 2021 figures from Colombia's Mining and Energy Planning Unit (UPME for its Spanish acronym)

5 Data for 2024 from Colombia's natural gas market manager *Gestor del Mercado de Gas Natural*.

Table B3.2
Indicators Summary

Acronym	Coverage	Description
IDEI	National	Industrial energy demand index
IDEM	National	Manufacturing energy demand index (excludes petrochemicals and refining)
IDED industrial	By Department	Departmental industrial energy demand index
IDED Manufacturing	By Department	Departmental manufacturing energy demand index (excludes petrochemicals and refining)

Source: own elaboration.

4. National energy demand indexes

The IDEI is constructed from the weighted sum of two indexes, using the average national consumption in 2018 as the benchmark year. The contribution of each energy resource to the value-added of the "electricity, gas, steam, and air conditioning supply" sector is considered to determine the weights based on quarterly GDP data at constant prices of the previous quarter.[6] Additionally, the relative weight of industrial demand for electricity and gas compared to total demand is assessed, multiplying this value by its respective contribution to value-added. Thus, the construction of the IDEI is:

$$IDEI_t = [(ID_{Elec_t} \times W_t) + (ID_{Gas_t} \times V_t)] \text{ where } W_t + V_t = 1 \quad (1)$$

Where,

$IDEI_t$ = industrial energy demand index in month *t*.
ID_{Elec_t} = electricity demand index in month *t*.
ID_{Gas_t} = gas demand index in month *t*.
W_t = weighting of the electricity demand index in month *t*.
V_t = weighting of the gas demand index in month *t*.

The indices are constructed using the benchmark average energy demand in 2018.

$$ID_{Elec_t} = \frac{Electricity\ Demand_t}{\frac{\sum Electricty\ Demand_{2018}}{12}};\ ID_{Gas_t} = \frac{Gas\ Demand_t}{\frac{\sum Gas\ Demand_{2018}}{12}}$$

And the weightings,

$$W_t = \frac{EPEI_t}{EPEI_t + EPGI_t}; V_t = \frac{EPGI_t}{EPEI_t + EPGI_t}$$

Where

$$EPEI_t = GDP_{Electricity_r} \times (PE_t); EPGI_t = GDP_{Gas_r} \times (PG_t)$$

and:

$$PE_t = \frac{Industrial\ Electric\ Demand_t}{Total\ Electricity\ Demand_t}; PG_t = \frac{Industrial\ Gas\ Demand_t}{Total\ Gas\ Demand_t}$$ [7]

6 Fixed weighting exercises were also performed, where the demand for each energy resource is multiplied by a 2018 average price. There are no significant differences among the two indicators.

7 For the calculation of the IDEM, petrochemicals and refineries are excluded from the industrial activities in gas demand. The rest of the methodology is identical for the indicator.

Where,

$GDP_{Electricity_r}$ = national GDP of "electricity supply" in quarter *r*.
GDP_{Gas_r} = national GDP of "gas, steam, and air-conditioning supply" in quarter *r*.
PE_t = industrial sector's share of total electricity demand in month *t*.
PG_t = industrial sector's share in the total gas demand in month *t*.

Determining a base year makes it easier to follow and interpret any index changes. Additionally, available information makes it possible to calculate the indicators as of January 2015. The use of fluctuating weights over time with respect to value-added captures structural changes in the composition of the energy matrix, either through supply or demand.

5. Department-level energy demand indexes

Like the IDEI, the IDED is constructed from the weighted sum of the electricity and gas indexes computed using the demand of the industrial sector. However, the department-level index includes an additional step in the methodology, as it must compute the share of each department within the national total to examine regional differences in energy consumption.

At the department level, electricity demand disaggregated by economic sector is not available. Therefore, the electricity demand of the unregulated market,[8] which includes all major demanders of this energy input, is used as a proxy for industrial electricity demand by department. Thus, the calculation is as follows:

$$IDED_{i,t} = \left[\left(ID_{Elec_{i,t}} \times W_{i,t}\right) + \left(ID_{Gas_{i,t}} \times V_{i,t}\right)\right] \text{ where } W_{i,t} + V_{i,t} = 1$$

$$ID_{Elec_{i,t}} = \frac{\frac{Electricity\ Demand_{i,t}}{\sum Electricity\ Demand_{i\ 2018}}}{12}$$

$$ID_{Gas_{i,t}} = \frac{\frac{Gas\ Demand_{i,t}}{\sum Gas\ Demand_{i\ 2018}}}{12}$$

$$W_{i,t} = \frac{EPED_{i,t}}{EPED_{i,t}+EPGD_{i,t}}; V_{i,t} = \frac{EPGD_{i,t}}{EPED_{i,t}+EPGD_{i,t}}$$

Where,

$$EPED_{i,t} = EPEI_t \times (PED_{i,t}); EPGD_{i,t} = EPGI_t \times \left(PGD_{i,t}\right)$$

and:

$$PED_{i,t} = \frac{Unregulated\ Electricity\ Demand_{i,t}}{\sum_{i=1}^{n} Unregulated\ Electricity\ Demand_{i,t}};\ PGD_{i,t} = \frac{Industrial\ Gas\ Demand_{i,t}}{\sum_{i=1}^{n} Industrial\ Gas\ Demand_{i,t}}$$

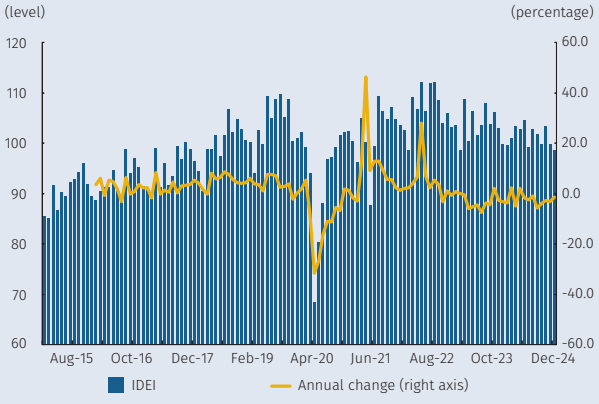
6. Comparative results

The IDEI and IDEM results capture significant events that have affected industrial and manufacturing activity in recent years (Graph B3.1). The yearly behavior observed in both panels shows the negative shock of the confinement resulting from the COVID-19 pandemic in 2020. Likewise, it identifies the adverse effects of the blockades during the national strike in May 2021, along with the strong industrial activity experienced in 2022 and its subsequent correction.

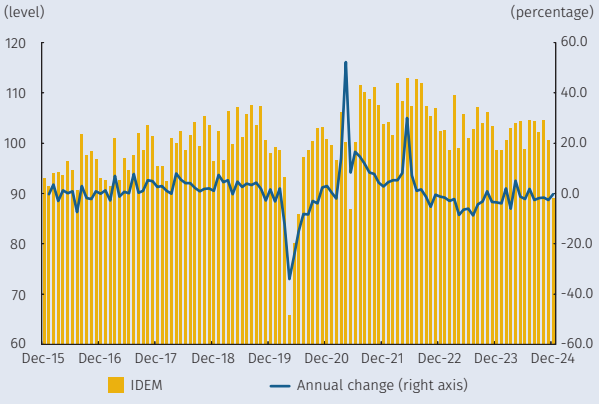
8 The non-regulated (NR) electricity market includes customers whose demand exceeds 55,000 kilowatt hours (kWh) per month or 100 kilowatts (kW) of power, and its rates are negotiated between the marketer and the customer, so prices fluctuate according to supply and demand. The largest customer of NR energy is the industrial sector, followed by mining and quarrying, while the rest of the economic sectors demand less than 2% of NR energy in the country.

Graph B3.1
National indexes of energy demand

A. IDEI



B. IDEM



Source: *Banco de la República.*

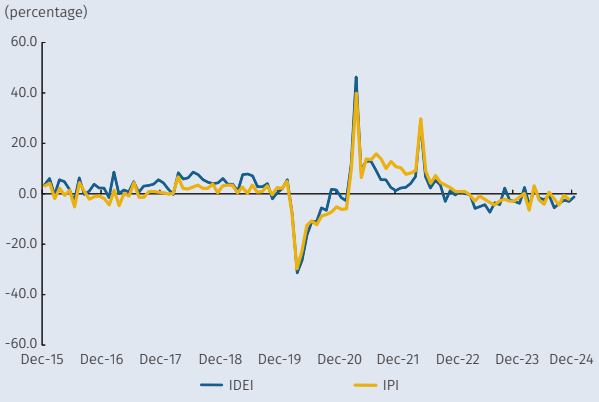
A comparison of the evolution of the IDEI with the annual change of the industrial production index (IPI) published by DANE illustrates a similarity between these two indicators, with the advantage that the former has a lag of ten working days, and the latter of about 45 calendar days (Graph B3.2, panel A). Similarly, the correlation between the IDEM and manufacturing production is observed (Graph B3.2, panel B).

As noted, the industrial sector represents one of the largest energy demanders, and the indicators provide a way to consistently monitor this activity's behavior during the analyzed period. However, it is essential to note that the differences observed between the energy demand indices and the industrial production indicators can be attributed to the characteristics of the high electricity and gas consumption sectors.

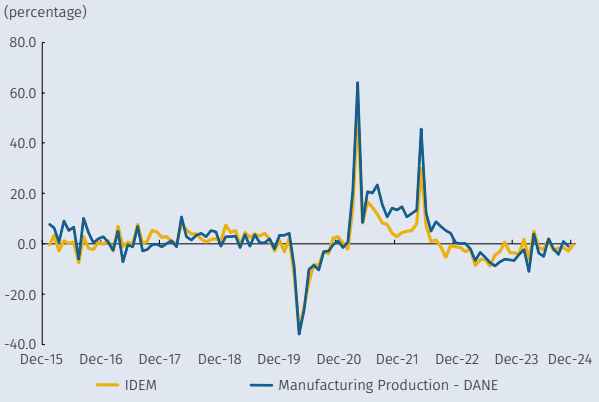
On the one hand, manufacturing sectors of plastics, iron, steel, and other electricity-intensive materials tend to significantly influence electricity consumption of this type of energy. On the other hand, activities such as mining, cement production, and glass manufacturing, which demand large volumes of gas, have a considerable weight in the consumption of this energy input. These differences in the contribution of sectors with high levels of energy consumption and those activities with more significant contributions in terms of value added can generate certain discrepancies between the energy indexes and the traditional indicators of industrial production.

Graph B3.2
Comparison of energy demand indexes and industrial indicators

A. IDEI and IPI



B. IDEM and manufacturing production (change)



Source: DANE and *Banco de la República*; calculations of the *Banco de la República.*

The industrial energy demand index (IDEI) and the manufacturing energy demand index (IDEM) show a high correlation with industrial activity indicators. Table B3.3 shows the contemporaneous correlations between the IDEI and IDEM with other leading manufacturing sector indicators. It also illustrates how those indicators are more informative than those which traditionally consider only the industrial sector's demand for electricity, especially in the recent period (post-pandemic), to the extent that they reflect the changes in the industry's production processes due to the increase in self-generation of energy from gas demand.

Table B3.3
Current correlations between energy indexes and industrial indicators

Indicators	Total	Jan-16 to Feb-20	Mar 20 to May-22	Jun-22 to Dec 24
IDEI				
Real manufacturing production	0.90***	0.59***	0.98***	0.77***
Industrial production index	0.90***	0.69***	0.95***	0.81***
Regional economic pulse (PER): Industry	0.81***	0.54**	0.86***	0.79***
Economic monitoring indicator (ISE): Secondary	0.90***	0.44***	0.96***	0.77***
IDEM				
Real manufacturing production	0.93***	0.46***	0.98***	0.68***
Industrial production index	0.91***	0.68***	0.94***	0.66***
Regional economic pulse (PER): Industry	0.78***	0.43**	0.85***	0.83***
Economic monitoring indicator (ISE): Secondary	0.90***	0.23	0.97***	0.68***
Electricity Index				
Real manufacturing production	0.94***	0.67***	0.97***	0.63***
Industrial production index	0.90***	0.84***	0.93***	0.61***
Regional economic pulse (PER): Industry	0.77***	0.69***	0.84***	0.77***
Economic monitoring indicator (ISE): Secondary	0.89***	0.50***	0.96***	0.64***

Statistical significance: * p < 0.10; ** p < 0.05; *** p < 0.01.
Note: The color of the cells corresponds to the magnitude and direction of the correlation, with green or red values indicating a positive high or negative low correlation, respectively.
Sources: DANE and *Banco de la República*; calculations by *Banco de la República*.

At the department level, the contemporaneous correlations of the changes in the industrial and manufacturing IDED with the DANE monthly manufacturing survey with territorial approach (EMMET for its Spanish acronym)[9] show a strong relationship (Table B3.4). This relationship statistic indicates that the IDED would be a valuable and timely tool to monitor industrial performance at the regional level.

The particularities of the productive structures of the different departments could explain the lower department-level correlations. The productive structure determines the composition of energy consumption in each region and, consequently, the demand for energy sources other than electricity and gas to carry out their industrial activities. For example, certain industries base their production on solid fuels, biomass, or alternative sources that are not directly reflected in the constructed indicators. For this reason, it is essential to contextualize the results considering the characteristics of local economies and their energy matrix.

9 The industrial and manufacturing IDED, both cover twenty departments and the Capital District, while the DANE statistics include twelve departments and the Capital District. Consequently, correlations can only be computed for these twelve departments and the Capital District.

Table B3.4
Contemporaneous correlations between department-level energy indices and industrial production

IDED	Industrial IDED	Manufacturing IDED
Antioquia	0.92***	0.91***
Atlántico	0.74***	0.73***
Bogotá	0.95***	0.95***
Bolívar	0.73***	0.78***
Boyacá	0.52***	0.51***
Caldas	0.85***	0.85***
Cauca	0.94***	0.94***
Córdoba	0.93***	0.93***
Cundinamarca	0.83***	0.82***
Risaralda	0.81***	0.80***
Santander	0.36**	0.72***
Tolima	0.60***	0.42***
Valle del Cauca	0.92***	0.92***

Note: correlations with EMMET for each department are calculated as of January 2019 because industrial index information is only available from 2018. The color of the cells corresponds to the magnitude and direction of the correlation, with green or red values indicating a positive high or negative low correlation, respectively.
Statistical significance: * p < 0.10; ** p < 0.05; *** p < 0.01.
Sources: DANE and *Banco de la República*; calculations by *Banco de la República*.

7. Conclusions

Electricity and gas play a pivotal role in the production of manufactured goods. An increase in the consumption of these energy resources usually occurs in tandem with a proportional increase in manufacturing output. This connection between energy demand and production suggests that monitoring electricity and gas consumption provides relevant information regarding manufacturing industry activity.

In this context, energy demand indices (EDI) are valuable and timely indicators for short-term monitoring of industrial activity. By aggregating two influential energy inputs, EDIs reliably reflect the underlying behavior dynamics of the industrial sector. Furthermore, their slight publication lag (ten working days) allows for early analysis that is highly correlated to official sector data.

Future research should consider aggregating other energy resources to expand the coverage of inputs used by the industrial sector; however, the low availability of information and disaggregation poses a serious limitation. Finally, the impact of changes in energy resource prices on demand for these resources and their implication in monitoring industrial manufacturing sector activity is worth evaluating.