Energy losses and Tariff influence on SAIFI & SAIDI – Latin America and Oceania

April 2024

Content

Objectives and conclusions

Aiming to assess the relationship between Quality of Service, Distribution Added Value (VAD), customer density, and electrical energy losses, public information from Latin America and Oceania companies was processed as part of our annual benchmarking program.

The statistical analysis concluded that quality of service indicators (SAIFI, SAIDI) have an inverse correlation with VAD (USD/MWh) and customers density (customer/length-MV network) and a direct correlation with energy losses.

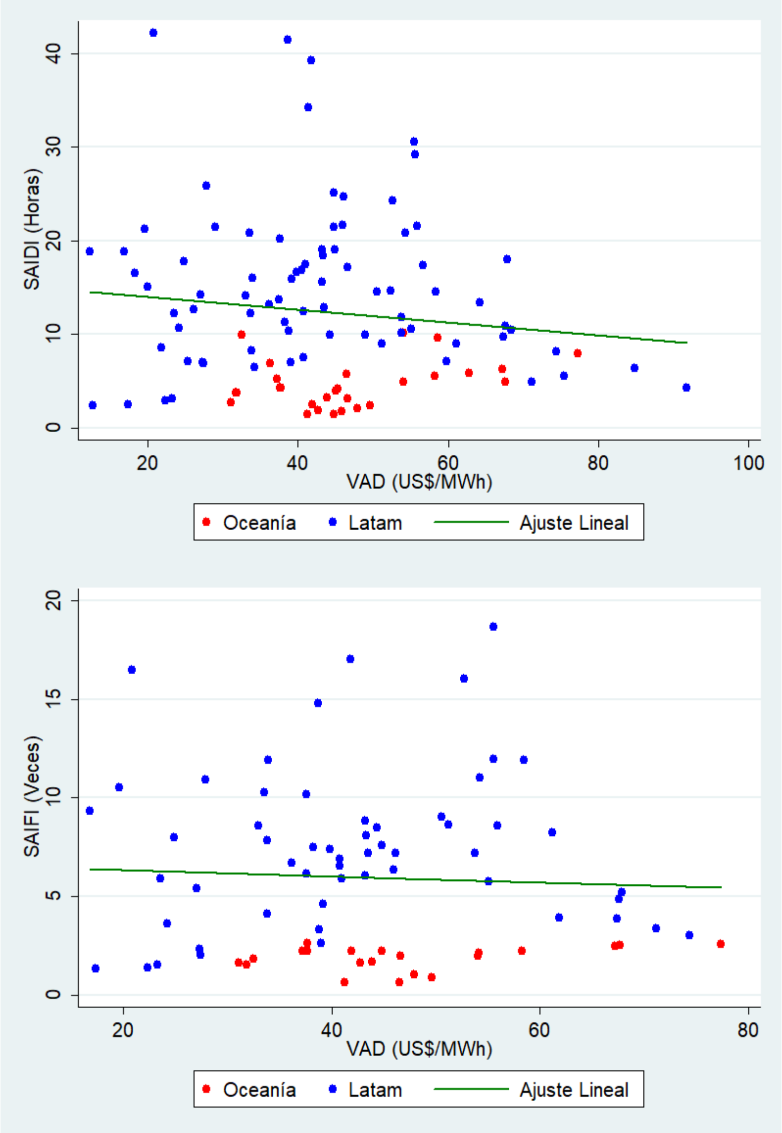
The results corroborate the relationship between energy losses and quality of service, which is expected given the deterioration that high energy losses cause to networks.

Regarding the behavior of companies by region, it was verified that companies show better quality of service and energy losses, with similar VAD values to those ones in Latin American companies.

Quality of service and VAD relationship

A negative relationship was verified between SAIFI/SAIDI indicators and VAD, may be linked to a lack of resources due to low VAD values:

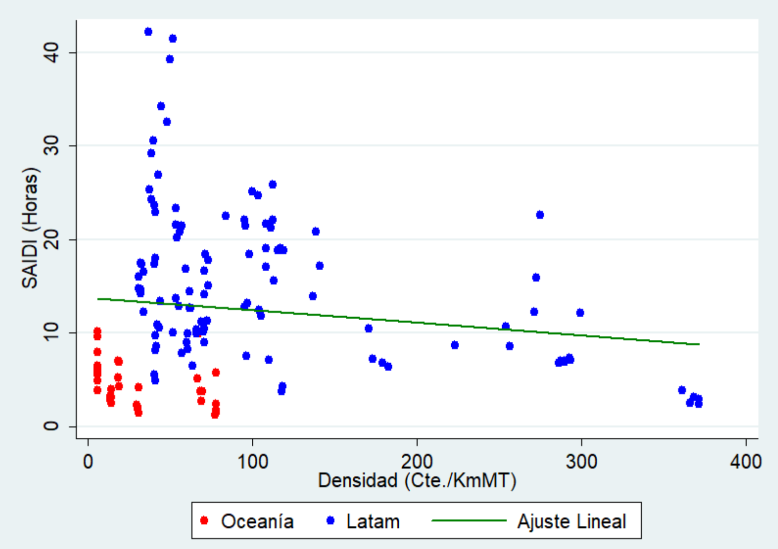
- **CAPEX/OPEX**: Low VAD could lead to a lack of resources for network upgrades and preventive and predictive maintenance actions.
- **Resources Management**: Low revenues could affect the recruitment and retention of suitable satff and training. The lack of skilled staff and the inability to keep up with best practices can impact in performance levels.

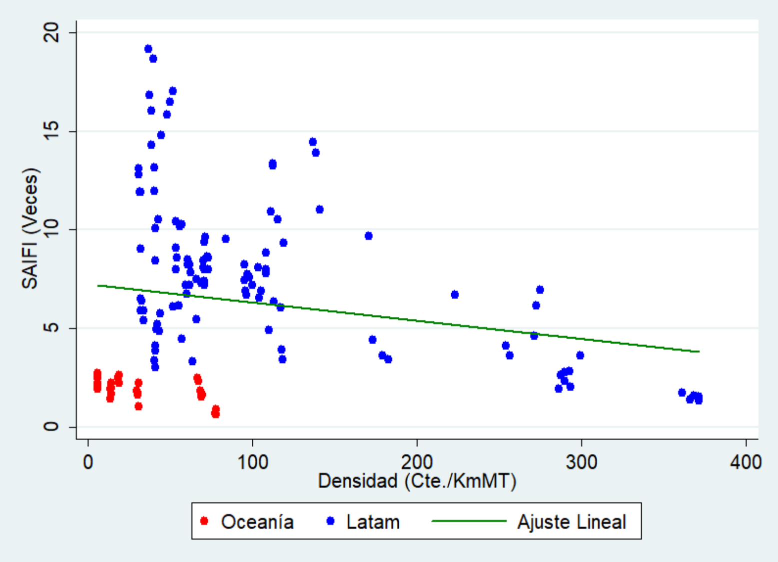


Quality of service and Customer density relationship

A negative relationship was verified between SAIFI/SAIDI indicators and customer density, which can be attributed to:

- **Less possibility of redundancy in the electrical infrastructure**: Low density might not justify the existence of backups for energy supply, which could increase the network's vulnerability to failures.
- **Lack of economic incentives**: In low density areas there may be fewer economic incentives to invest appropriately.
- **Slower response times**: Low density regions are usually remote areas with difficult access and consequently longer response times

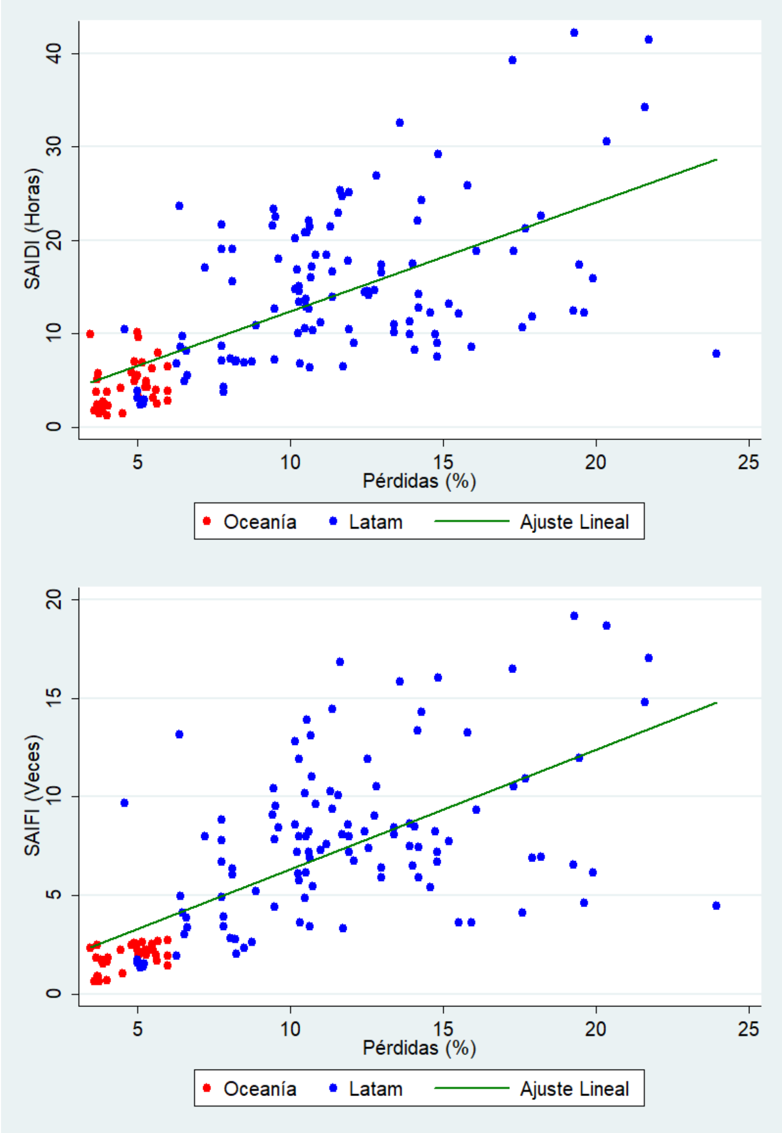




Quality of service and Energy Losses relationship

A positive relationship was verified between SAIFI/SAIDI indicators and technical and non-technical energy losses, which could be linked to the following factors:

- Energy theft: Associated with illegal connections or meter tampering, which can cause unplanned interruptions and affect quality of service indicators.
- Infrastructure: A high level of electrical losses generally overload facilities, particularly old, obsolete, or poorly maintained networks. This could result in higher quality of service indicators.
- Inefficient cost allocation: Electrical energy losses generate additional O&M costs, which could lead to reduce the preventive maintenance and infrastructure investment budget. .



Statistical models

Model Setup

$$SAIDI\ (VAD, Losses, Density) = \alpha 1 \times VAD_{i(t-1)} + \alpha 2 \times Losses_{i(t)} + \alpha 3 \times Density_{i(t)} + \lambda_{i(t)}$$

$$SAIFI\ (VAD, Losses, Density) = \beta 1 \times VAD_{i(t-2)} + \beta 2 \times Losses_{i(t)} + \beta 3 \times Density_{i(t)} + \mu_{i(t)}$$

Where:

- SAIDI: System Average Interruption Duration Index (hr/year)
- SAIFI: System Average Interruption Frequency Index (#/year)
- VAD: Distribution Added Value (US$/MWh-year)
- Losses: Difference between the energy purchase and sale (%)
- Density: Length of medium voltage network per customer (customer/km of network MT).

5 years data from 37 companies (2018-2022) was considered.

Statistical models

Model Estimation and results analysis

$$SAIDI\ (VAD, Losses, Density) = -0{,}0704 \times VAD_{it-2} + 1{,}0997 \times Losses_{it} - 0{,}0187 \times Density_{it} + 5{,}6982$$

$$SAIFI\ (VAD, Losses, Density) = -0{,}0194 \times VAD_{it-2} + 0{,}6534 \times Losses_{it} - 0{,}0112 \times Density_{it} + 0{,}823$$

- An increase of one unit in VAD (US$/MWh) from two previous periods (t-2) correlates with a decrease of 0.0704 annual hours (4:13 minutes) of SAIDI and 0.019 of annual frequency of SAIFI.
- An increase of one percentage point in Losses (%) correlates with an increase of 1.0997 annual hours (1:05 hours) of SAIDI and 0.653 of annual frequency of SAIFI.
- An increase in one unit of Customer Density (customer/kmMT) correlates with a decrease of 0.0187 annual hours (1:07 minutes) of SAIDI and 0.011 of annual frequency of SAIFI.

The explicative variables are significant at a 5% confidence level.

Applied Methodology

Regression Analysis

Data and methodology applied for the analysis:

- Data from 37 electric distribution companies from Latin America and Oceania.
- 2018 to 2022 period was considered.
- Data source was public information from Financial Statements, Annual Reports, Official Reports, or similar agencies.
- Two fixed-effects models were estimated (Hausman Test and Breusch and Pagan Lagrangian Test). Both models were adjusted for heteroscedasticity (Modified Wald Test) and autocorrelation (Wooldridge Test).
- Significant relationships between quality indicators and lagged VAD, customer density, and energy losses were explored.

Applied Methodology

VAD: General Concept

A global VAD for each distributor was determined based on public information using the following equation:

$$VAD = \frac{(US\$\ Revenues\ - US\$\ Supply\ Cost)}{Sold\ Energy}$$

- $Revenues: Total annual billing for energy and power (E&P) sales to end customers in US$
- $SupplyCost: Total annual supply expenditure for energy and power purchases (Including Transmission) in US$
- SoldEnergy: Total annual energy sold to customers (MWh)

This methodology is an approximation to VAD as energy losses could distort the obtained result.

Applied Methodology

Energy Losses: General Concept

In cases where the global electrical energy losses were not directly specified, the value was estimated based on public information using the following equation:

$$\%Losses = \frac{(Purchase\ Energy\ - Sold\ Energy)}{Purchase\ Energy}$$

- PurchaseEnergy: Total annual energy purchased; - incoming energy into their networks - (MWh)
- SoldEnergy: Total annual energy sold to customers (MWh)

%Losses is referred to the incoming energy into the distributor's networks.

Panel of Companies

Latin America

- AES ELETROPAULO (Brasil)
- CENS (Colombia)
- CHILECTRA (Chile)
- E.E. CENTRO SUR (Ecuador)
- EDEA (Argentina)
- EDECHI (Panamá)
- EDELAP (Argentina)
- EDEMET (Panamá)
- EDEN (Argentina)
- EDENOR (Argentina)
- EDES (Argentina)
- EDESA (Argentina)
- EDESUR (Argentina)
- EDET (Argentina)
- EEGSA (Guatemala)
- EEP (Colombia)
- ELECTRO ORIENTE (Perú)
- ELECTRO PUNO (Perú)
- ELECTRO SUR ESTE (Perú)
- ELECTRODUNAS (Perú)
- ELECTROSUR (Perú)
- ELEKTRA (ENSA) (Panamá)
- ENEL PERÚ (Perú)
- ENOSA (Perú)
- ENSA (Perú)
- ESSA (Colombia)
- HIDRANDINA (Perú)
- LIGHT (Brasil)
- LUZ DEL SUR (Perú)
- SEAL (Perú)

Oceania

- Ausgrid Sydney (Australia)
- Ergon Queensland (Australia)
- Essential Gran Sydney (Australia)
- POWERCO (New Zeland)
- Powercor Melbourne (Australia)
- VECTOR (New Zeland)
- WEL NETWORKS (New Zeland)

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