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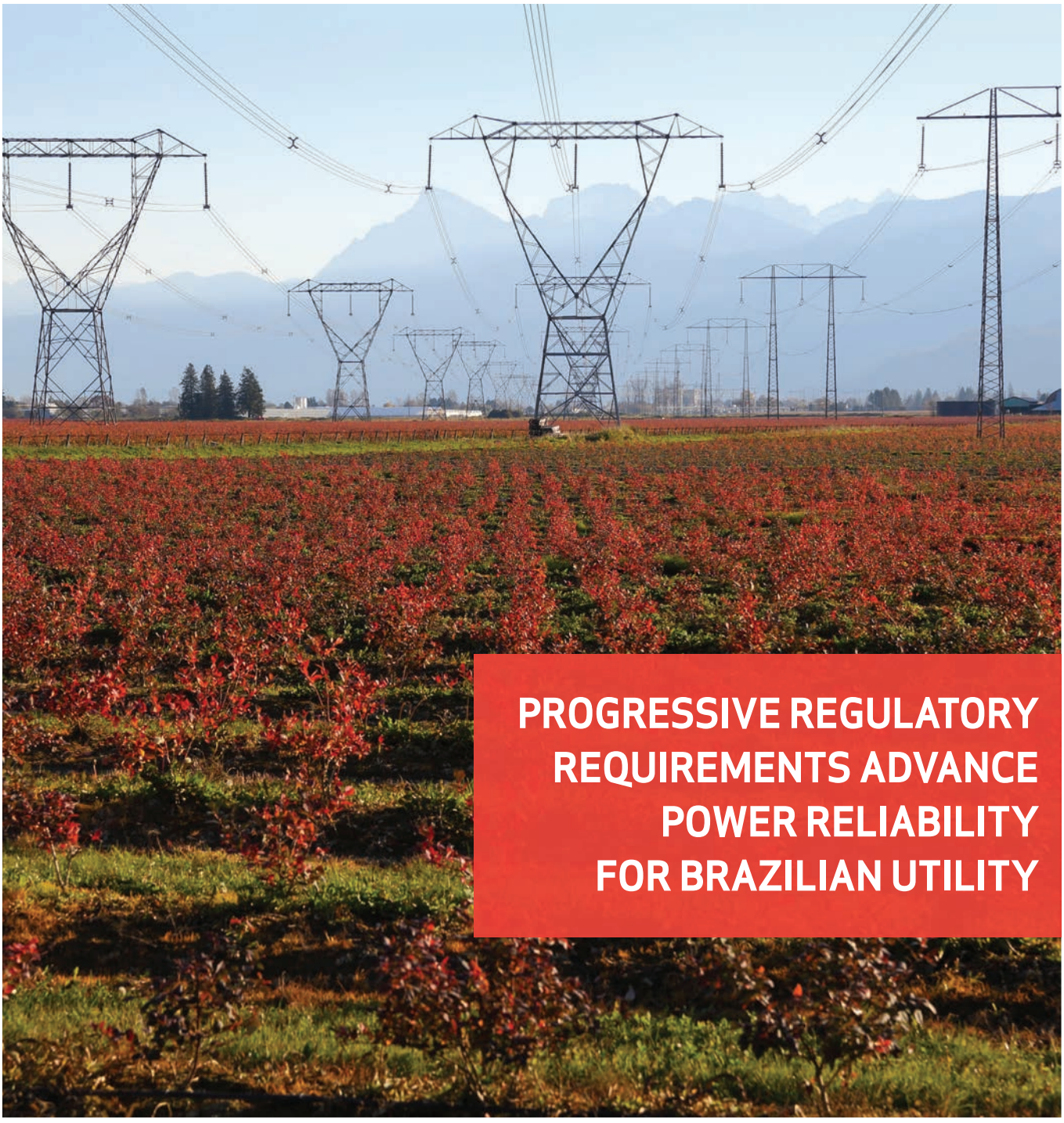

PROGRESSIVE REGULATORY REQUIREMENTS ADVANCE POWER RELIABILITY FOR BRAZILIAN UTILITY

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JULIO S. OMORI AND ANDREW JONES

Evolving regulatory structures

Utility regulatory landscapes are evolving, in North America, as well as across the globe. The convergence of such factors as aging infrastructure, a heightened commitment to the customer experience and grid-modernization efforts are pushing the grid forward faster and more profoundly than ever.

In particular, Brazil has experienced significant changes in electricity regulatory requirements over the past several decades. Chief among them, Brazil's electricity regulations were restructured to allow for foreign investment in power generation. New legislation reformatted the electricity sector, requiring all utility concessions to be granted through a public bidding process.

In response to Brazil's new competition in the electricity sector, an electricity regulatory agency was created. Agência Nacional de Energia Elétrica (ANEEL) is responsible for inspecting and regulating service quality for utility customers and for preserving service providers' economic viability. The agency manages utility concession contracts in Brazil, and it revises corresponding System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) requirements every five years.

In 2015, ANEEL's influence began to change Brazil's utility regulatory structures. The regulatory agency enacted a strategic plan that required utilities with suboptimal SAIDI and SAIFI performance and low customer reliability to improve their services, presenting the risk of losing the concession for contracts that were being renewed in 2015. The agency individually monitored utilities' financial results and SAIDI and SAIFI scores yearly.

Then, during a periodic concession contract renewal in 2016, ANEEL established unprecedented measures to hold utilities accountable for improving SAIDI and SAIFI indices on a yearly basis. The first of these measures centered around a dividend payment restriction. ANEEL approved a new resolution that restricts utility dividend payments to a new legal minimum — 25 percent of their net profit. The restriction is applied if a utility exceeds the SAIDI and SAIFI indicator limits for two consecutive years or three times within five years. In 2018, five Brazilian utilities had their dividend payments restricted to the legal minimum because they failed to meet the new requirements. This demonstrated a clear need for reliability improvements across many utilities in Brazil.

The second measure declared that, if utilities exceed the new SAIDI and SAIFI thresholds for two consecutive years or during the last year of the five-year period, they would lose their concessions. ANEEL's latest requirements have given Brazilian utilities an ultimatum: substantially improve reliability or lose their concession contracts entirely.

Five years after the new regulatory requirements were enacted, 2020 is a landmark year for these organizations because ANEEL will evaluate its progress during the final year of the five years.

"There are significant shifts in utility regulatory structures around the world right now, and Brazil is one example of how these changes are pressuring utilities to reevaluate conventional practices," said Andrew Jones, senior vice president of global sales for S&C. "COPEL's swift response to these changes demonstrates how quickly utilities can see success even in more complex and intensified regulatory environments."

Advanced lateral protection: A strategy for reliability improvement

One of the largest service providers affected by ANEEL's recently enacted standards was COPEL, Brazil's fourth-largest utility located in the state of Paraná. Its distribution system consists of 195,459 kilometers (121,452 miles) of lines serving 11 million customers. Although the state has many businesses and dense populations in its 395 municipalities, many of important industrial operations, such as large-scale poultry and tobacco farms, are located in rural areas. This means electric loads, especially those in key commercial locations, are spread across COPEL's system throughout Paraná and are not concentrated only in cities.

Because of ANEEL's recent mandates, COPEL had to quickly decrease its SAIDI performance, mainly in its rural-service areas, which had the poorest reliability. Reducing SAIDI motivated COPEL to search for new solutions to meet ANEEL's requirements while in turn reduce operating costs and provide a return on investment.

To rapidly achieve considerable SAIDI improvement, COPEL targeted rural laterals with the poorest reliability. Outages that occurred from temporary faults in rural service areas had a large negative impact on COPEL's SAIDI score because of the time required to send crews to remote rural areas. In addition to the reliability consequences, the cost to send crews to these locations inflated the utility's operations and maintenance expenses. Electrical feeders in Paraná are typically very long, some stretching across more than 600 kilometers (372.8 miles). Single-wire earth return (SWER) transmission lines provide power to distribute in COPEL's rural areas but pose substantial challenges operationally.

It was evident to COPEL that meeting ANEEL's strict reliability goals required a departure from the utility's previous protection strategy. Therefore, as a replacement for fuse cutouts, the utility piloted several varieties of simplified single-phase reclosers.

Ultimately, the utility selected a Chicago-based, global equipment and electric power systems solutions provider and its single-phase, cutout-mounted recloser to meet ANEEL's requirements to improve overall system reliability. This advanced lateral-protection solution detects whether faults are permanent and restores power automatically when they are temporary, preventing unnecessary sustained outages.

After the first-phase of COPEL's deployment, the utility experienced a 68.1 percent reduction in SAIDI, reducing the average outage duration by 45 minutes and permitting the utility to meet the stringent performance requirements ANEEL had set. The initial deployment also enabled the utility to avoid long, costly truck rolls. Because of this, COPEL realized an operating-cost reduction equivalent to 20 percent of its investment value from the initial deployment. This strategy change frees up COPEL's crews so they are available for other, higher-value-added services that benefit its end customers.

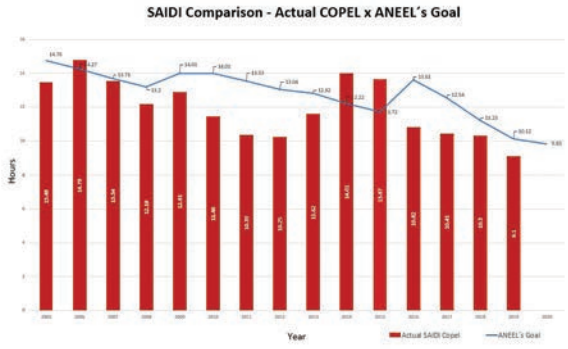

Figure 1: ANEEL's imposed SAIDI limits (blue) versus COPEL's actual SAIDI performance (red).

As shown in **Figure 1**, the blue line represents the aggressive SAIDI limits ANEEL imposed on COPEL. The red bars indicate the actual yearly SAIDI results COPEL achieved after deploying the single-phase, cutout-mounted recloser on its system in 2016. COPEL was not only able to meet ANEEL's limits but surpassed the necessary reduction in SAIDI.

After installing the single-phase reclosers systemwide in subsequent deployments, the power-reliability improvements were immediate. COPEL realized an overall SAIDI reduction of 58.6 percent and avoided 140,000 truck rolls in three years. "Adopting an advanced lateral-protection strategy with [the provider's single-phase, cutout-mounted reclosers] enabled us to significantly reduce our SAIDI rating and meet ANEEL's strict utility regulatory requirements," said COPEL's Smart Grid and Special Projects Superintendent Julio S. Omori. In 2019, COPEL's SAIDI score for the first time ever was in the single digits.

End-customer satisfaction

Beyond the SAIDI improvements that the single-phase cutout-mounted reclosers offered COPEL, the devices also improved reliability for the utility's end customers. Outages can cause costly disruptions to businesses and households alike, especially those at the edge of the grid that typically wait longer for power to be restored. Because many of COPEL's customers include important industrial operations located in rural areas, providing them with reliable power is essential for the country's economy. Long outages significantly impact those customers and have the potential to shutter their critical operations for extended periods, given their location at the grid edge.

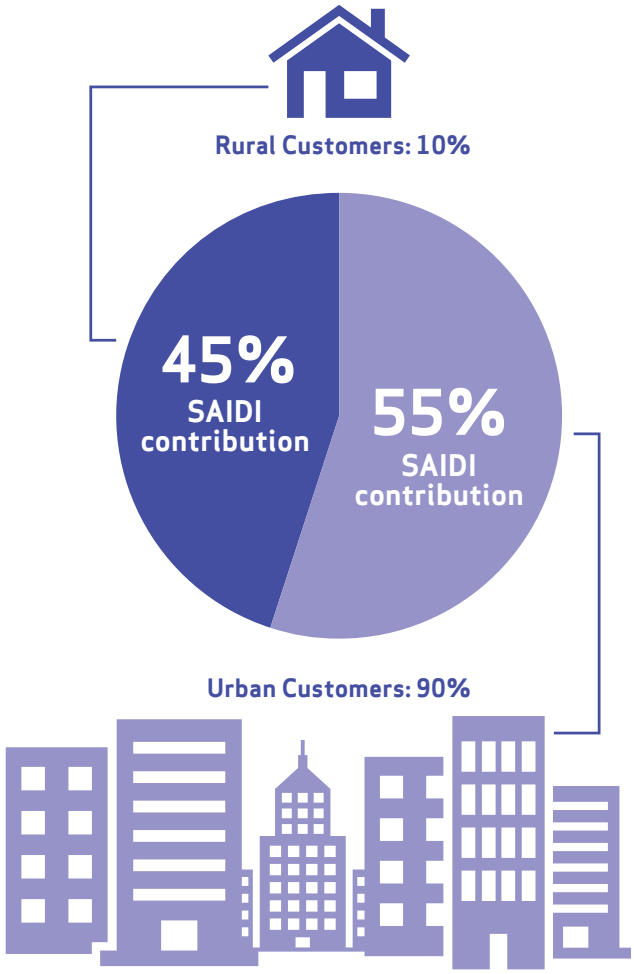

Figure 2: The average SAIDI contribution shared between COPEL's urban and rural customers.

As shown in **Figure 2**, the bulk of COPEL's customers are located in urban areas, with only 10 percent of total customers located in rural locations. However, a great disparity existed between the service reliability of the utility's urban and rural service areas. Though rural customers represented the minority of COPEL's base, they experienced significantly more outages on average than urban customers, contributing to 45 percent of the utility's overall SAIDI score. This disproportion of reliability between urban and rural customers was the impetus for COPEL to invest in advanced lateral protection in their rural service areas.

COPEL learned the solution provider's single-phase, cutout-mounted reclosers were an essential tool to improve the performance reliability on its distribution networks and its three-phase 13.8-kV and 25-kV laterals and single-phase 34.5-kV laterals. Not only do the devices prevent temporary faults from becoming sustained outages, keeping important operations online — even at the grid edge, they only blink affected laterals, avoiding momentary interruptions on feeders.

"These single-phase, cutout-mounted reclosers have brought numerous benefits to our system and our operations," said Omori. "Not only are we keeping even momentary interruptions from impacting our customers, but we're also avoiding numerous trips to the field. This allows our crews to focus on bigger issues and restore power faster to better serve our customers."

ABOUT THE AUTHORS:

Julio S. Omori is an electrical engineer, specialist in systems automation for COPEL. He received his master's degree in electrical engineering and industrial informatics from the Technological University of Paraná – Brazil. He is superintendent, smart grid and special projects of Copel Distribuição with 17 Years in the company.

Andrew Jones is the senior vice president of global sales at S&C Electric Company. He previously was the managing director for the S&C Europe Middle East and Africa Business Unit-based in the United Kingdom. Jones holds an MBA from Sheffield University and a degree in mechanical engineering from Swansea, UK. He is a member of the Institute of Quality Assurance UK. Through his work with and membership in trade associations, he served as an advisor to government in the UK and most recently was the chair of the European Working Group for the Market Design for Energy Storage. Andrew is a member of the UK Institute of Directors.