SUCCESS CASE 61.2025

LV Network proactive failure detection with Smart Metering

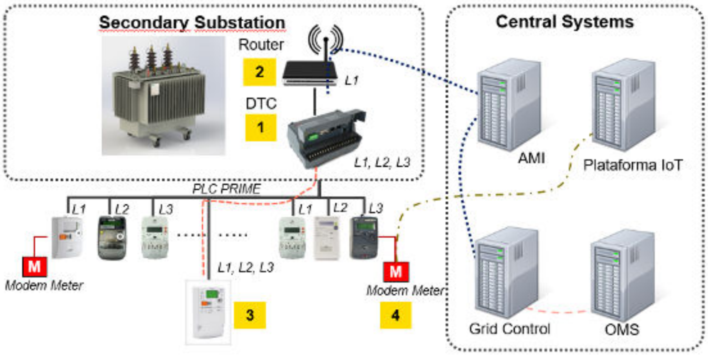
SMART METERING EVENTS FOR A PROACTIVE DETECTION OF NETWORK FAILURES

THE CHALLENGE

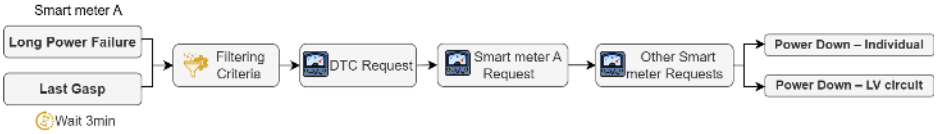
Over the past year, E-REDES has been actively working on solutions and system implementations aimed at leveraging existing smart metering technology to enable proactive fault detection in low-voltage networks. The target is to identify, and in some cases even solve, power outages before customers contact. While this is still the beginning of the journey, the initial results have been encouraging, demonstrating the potential of these advancements to improve both grid reliability and customer satisfaction.

THE SOLUTION

Smart Grid Infrastructure is designed with built-in fault detection features such as spontaneous events and last-gasp functionality, ensures proactive outage alerts. Integrated communication and autonomy across devices: DTC (Distribution Transformer Controller) [1], smart meters [3], and modems [4] enhance grid reliability, enabling real-time data transmission even during power failures and supporting operational efficiency.



Given the high volume of data from smart grid devices, E-REDES developed custom algorithms to process alarms efficiently. These algorithms aim to reduce false positives, determine the impact of faults, and group multiple related alarms into a single event, improving decision-making, detection accuracy, and grid reliability.



Although the algorithm uses device events as input, it validates them by querying the DTC, meter, and neighboring meter, filtering false positives and determining whether the alarm is valid and its content.

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Following a thorough investigation into the electrical measures and correlation of different alarms, the system determines the scope of the fault and generates one of the following intelligent alarms:

- Power Down – Individual: when the fault only affects one customer.
- Power Down - Low Voltage Circuit: when the fault covers two or more customers on the same LV circuit.
- Power Down – DTC (secondary substation): when the fault covers two or more LV circuits.

All these new alarms are now available to the dispatch operators and allow them to detect and locate faults before clients' notifications, allowing them to dispatch field teams to solve grid problems. Some others smart alarms are also implemented, such has MV phase faults or neutral losses (also use smart meter or DTC events), all of these are correlated with the new ones to ensure that the operator has the relevant information to guarantee grid restoration as soon as possible.

Additional smart alarms have been implemented to detect fault restoration events. These alarms leverage power-up and phase-up signals generated by DTCs, meters, and meter modems. This event data serves as input to trigger mechanisms similar to those used for fault detection—namely filtering, aggregation, and validation processes.

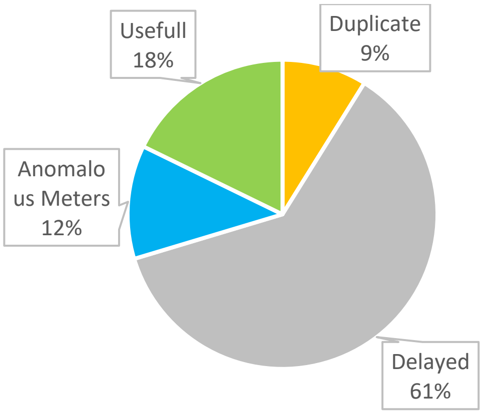
These restoration alarms play a crucial role in confirming that a fault has been fully resolved. By analyzing the reactivation of devices and phases, the system can more reliably determine whether service has been restored across the affected network segments.

MAIN ACHIEVEMENTS

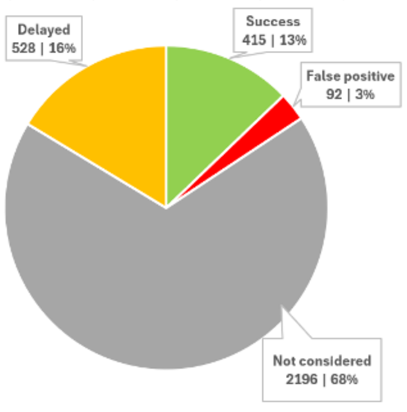
It is estimated that over 5,000 events are received daily, but not all of them are relevant to the intended use cases. It is important to note that only 18% of the events collected from field devices are useful for these use case. Those 18% will be the trigger for the smart alarms, but not all of them will be pass through the validation stage, only 24% of those 18% (approximately 4% of the total) result in actionable outputs usable by the dispatch operator.

These results show the importance of the filtering process to make sure that for this use case, only reliable and real time information is considered.

Algorithm Input: SmartGrid Events



Results from smart alarms analysis



Left graph show the events generated by the smart grid infrastructure and the right graph the smart alarms results, analyzed by dispatch team.

Several alarms are not considered for several reason (related to MV faults, schedule works, already solved problems, etc.). Some other are delayed because some client already reported the issue.

Since these features were introduced very recently, it was decided that all smart alarms should be reviewed and handled by dispatch operators. This is one of the reasons why, in some cases (16%), customers report grid issues before a field team is sent. Nevertheless, even in delayed cases, the alarms often help identify the most probable fault location. However, the next step will be to optimize the end-to-end process, removing all the redundant or unnecessary manual operations.

The current false fault rate is around 3%. In these situations, field teams are dispatched, but either no issue is found or access to the meter is not possible. A significant number of LV installations have smart meters located inside customers' homes, which makes fault detection more challenging when the customer is not present. Algorithm adjustments are being made to distinguish these installations, and a messaging mechanism is being considered to interact with customers in such scenarios.

Out of all smart alarms generated, approximately 16% result in field dispatches, with a current success rate of 82% in anticipating actual issues.

KEY SUCCESS FACTORS

Although some of the alarms used as inputs have been available for some time, leveraging their full potential was previously challenging. The success of this initiative relies heavily on the implementation of advanced algorithms capable of filtering, validating, and correlating the data effectively.

Another critical factor is the integration within the AMI ecosystem, which enables the algorithms to actively interact with field devices—triggering requests and retrieving real-time status information. This dynamic capability significantly enhances responsiveness and accuracy.

Finally, the seamless integration with the Outage Management System (OMS) plays a vital role in the aggregation phase and is essential for enabling full automation of the detection and response processes.

WAY FORWARD

The results have been very positive, representing a paradigm shift by enabling low-voltage grid sensing, anticipating faults, and enhancing the quality of service delivered to our customers.

E-REDES remains committed to continuously improving these implementations and maximizing the potential of the smart grid infrastructure. While there is still much to be done, the current results give us the confidence to keep pushing forward with our ambition: to detect a significant number of faults before they are reported by our customers.