

SUCCESS CASE 17.2025

AI-Powered Fraud Detection

AI-POWERED FRAUD
DETECTION IN LV NETWORKSReal example of
meter tampering

THE CHALLENGE

Electricity fraud in low-voltage (LV) networks is increasing due to illegal connections and meter tampering. These activities cause economic **losses**, **voltage imbalances**, and **infrastructure degradation**, while also compromising **service quality** and creating **safety risks** such as electrical fires and electrocution.

A common form of fraud involves manipulating meters to report lower energy consumption, significantly reducing billing. Detecting these fraudulent activities is becoming more difficult because smart meters no longer require on-site inspections, which previously helped identify **tampering**. Therefore, identifying fraudulent meters is a major challenge for electric utilities. To address this issue, indirect detection methods have been developed using consumption pattern analysis and big data techniques. However, these methods often have low reliability, with success rates frequently below 50%. The main limitation is their inability to effectively differentiate between legitimate and fraudulent consumption patterns, allowing fraudulent activities to go undetected.

TECHNOLOGY ENABLES SOLUTIONS

UFD deployed smart meters across its full network in 2018 and will soon replace all meters with next-generation equipment. The DSO is also installing advanced sensors to monitor LV feeders in many secondary substations, collaborating with technology providers such as [Merytronic](#), [Pronutec](#), and others. These sensors currently cover 50% of the network, monitoring electricity for 75% of UFD's customers, making the company a **global leader in LV line monitoring**. The data collected through the smart meters and sensors enables improved **network visibility**, **real-time fault detection**, and **automatic topology correction**.

Additionally, UFD has implemented a fully automated system to detect **meter tampering** using shunts, in collaboration with [Ariadna Grid](#).

MAIN ACHIEVEMENTS

The detection system uses data from feeder sensors and smart meters, **applying artificial intelligence (AI) to calculate a consumption ratio for each**. This ratio represents the consumed energy divided by the registered energy. Even for feeder sensors measuring total consumption for over 150 meters, the system can calculate individual ratios for each smart meter. Based on the system's calculations, if a smart meter's ratio equals 1, its readings are validated as accurate. Conversely, if the ratio exceeds 1, a **shunt detection alert is triggered**. Beyond fraud detection (Figure 1), the system also quantifies the amount of unregistered energy.

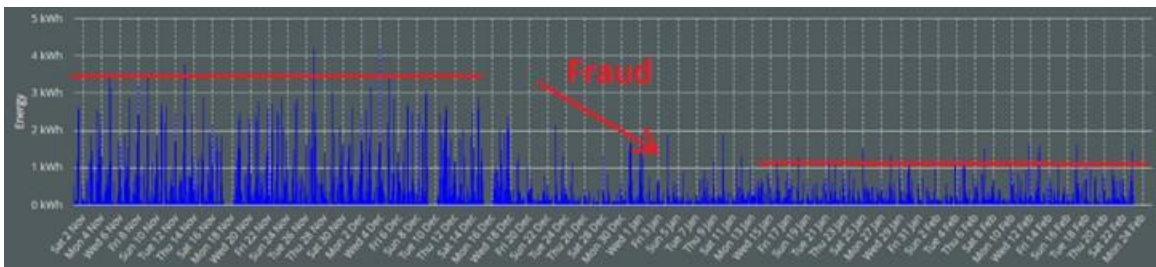


Image 2: Hourly consumption energy profile of a meter (blue). Although the energy consumption pattern remains the same, the absolute values decrease due to fraud (as highlighted by the red line).

For instance, a ratio of 4 indicates that the utility is billing only for one unit of energy while three additional units are being stolen for that particular meter (Figure 2). By multiplying this ratio by the hourly energy profile, the system can **calculate detailed energy losses**.



Image 3: Tampering ratio evolution. The meter tampering ratio is defined as $\text{ratio} = \text{consumed energy} / \text{registered energy}$. In the chart, green means $\text{ratio}=1$ (not tampered) and red means $\text{ratio}>1$ (tampered). The grey zones indicate that the algorithm is working on a new result.

KEY SUCCESS FACTORS

The **success of UFD's AI-powered fraud detection system** is due to several key factors:

- **Advanced data integration**, combining data from smart meters and feeder sensors for accurate fraud detection.
- **AI and automation**, using AI to identify irregular consumption patterns and trigger fraud alerts, quantifying unregistered energy losses.

- **Scalability and reliability**, monitoring over 3 million smart meters and generating tens of targeted inspections every week with 95% accuracy.
- **Strategic collaboration**, partnering with Ariadna Grid and trusted providers like Merytronic and Pronutec.
- **Operational efficiency and cost reduction**, reducing inspection times, optimising fieldwork, lowering costs, and enhancing resource allocation.

These factors supported UFD in automating LV network management and setting a new industry standard for AI-powered fraud detection in energy distribution.