

# AI Driven Consumption Anomaly Detection For Smart Meters

## Consumption Anomaly Detection: A Data-Driven Approach

In today's utility landscape, detecting consumption anomalies is essential for enhancing operational efficiency, protecting revenue, and strengthening customer trust. The Consumption Anomaly Detection initiative was developed to achieve these goals by leveraging advanced AI and machine learning (ML) models. This project has revolutionized how a major electricity distribution company in the Middle East identifies and manages irregularities in consumption data.

By analyzing vast amounts of data from millions of smart meters, the system detects discrepancies caused by energy theft, faulty meters, or unusual consumption patterns. These insights enable the company to take proactive measures, reduce inefficiencies, and ensure greater operational transparency.

Seamlessly integrating with the company's existing infrastructure, the initiative pulls data from Head-End Systems (HES), the Meter Data Management System (MDMS), and other sources. As a result, the system provides real-time anomaly detection, allowing the company to address issues proactively and optimize resource allocation across its distribution network.

## How It Was Done: The Journey from Data to Insights

The implementation of the Consumption Anomaly Detection system for the company was carefully planned and executed, utilizing advanced AI/ML techniques to ensure high accuracy and scalability. The process began with the integration of diverse data sources, including voltage, current, and consumption data from HES, along with event and alarm logs and weather information. These datasets formed a strong foundation for the AI/ML models to effectively detect and predict anomalies.

At the core of the system is its ability to learn from historical data to anticipate irregularities.

By analyzing months of past consumption patterns, the model established robust baselines for distinguishing between normal and anomalous behaviors.

Through the integration of voltage and current profiles, environmental factors such as temperature and humidity, and event-driven deviations, the AI model achieved an unprecedented level of granularity in its insights.

## An Iterative Training Approach to Enhance Model Accuracy

### Advanced Feature Engineering

- Raw data was transformed into meaningful predictors, including peak load hours, consumption variations influenced by weather conditions, and deviations triggered by specific events.

### Precision Validation

- Each iteration was rigorously tested against strict performance metrics such as precision, recall, and false-positive rates, ensuring accurate and actionable insights.

### Adaptive Learning

- The models continuously adjusted based on field feedback, evolving dynamically to remain accurate and resilient in changing conditions.

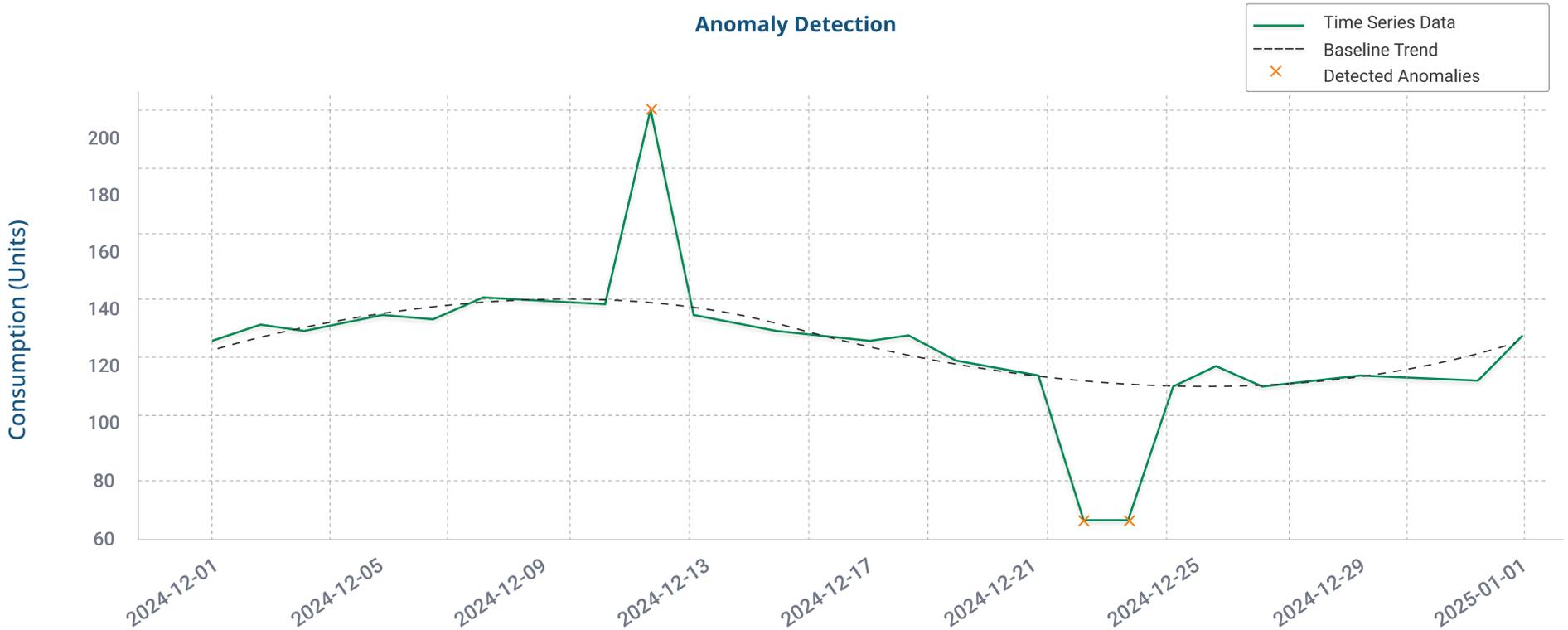
During deployment, seamless integration with the company's operational workflows was a top priority. Interactive dashboards provided clear visualizations, empowering field teams and decision-makers to respond quickly and effectively.

By leveraging AI/ML models trained on extensive datasets, the system achieved exceptional accuracy in detecting consumption anomalies, setting a new standard for operational efficiency in utility management.

## Impresa Solutions:

- Impresa Insights Data Platform
- Revenue Assurance Insights

**Anomaly Detection**



**Business Outcomes**

The implementation of this solution brought transformative benefits to the company. By automating anomaly detection, the utility significantly reduced revenue losses caused by energy theft, faulty meters, and poor connections. The system’s ability to identify and resolve discrepancies early ensured billing accuracy and enhanced customer trust.

Operational efficiency improved substantially as AI-driven automation replaced manual processes. This enabled the company to allocate resources more effectively, prioritizing high-impact tasks over time-consuming anomaly checks. Additionally, the system’s

actionable insights empowered the company to make data-driven decisions for grid optimization and resource planning.

From a customer standpoint, the initiative enhanced transparency and accountability. Consumers benefited from faster issue resolution and more accurate billing, strengthening their trust in the company. Beyond immediate operational improvements, the initiative positioned the company as a leader in leveraging advanced technology to meet the evolving demands of modern energy management.

**Summary**

The Consumption Anomaly Detection initiative showcases the successful application of AI/ML in identifying and resolving consumption irregularities within the company’s operations.

By enhancing operational efficiency and aligning with sustainability and customer satisfaction goals, the project lays the groundwork for future digital advancements. This initiative reinforces the company’s commitment to building a resilient and efficient utility network.



**Smart meter consumption anomaly detection is transforming our operations with AI centric insights built using Impresa.ai platform, we can identify irregular usage patterns, improve billing accuracy, and reduce revenue losses - ultimately building stronger customer trust.**

**- Head of Smart Meter Operations,  
A Large Middle East Electricity Distribution Company.**

