

AI Driven Consumption Anomaly Detection For Smart Meter Data

What This Is About? Addressing Irregularities: A Data-Driven Approach

In today's utility landscape, identifying consumption anomalies is critical for improving operational efficiency, safeguarding revenue, and enhancing customer trust. The Consumption Anomaly Detection initiative was designed to address these objectives by deploying advanced AI and machine learning (ML) models. This project transformed how a large Electricity distribution Company in the Middle East detects and manages irregularities in consumption data.

By analyzing data at scale from millions of smart meters, the solution identifies discrepancies caused by energy theft, faulty meters, or unusual consumption behaviors. These insights provide actionable intelligence to reduce inefficiencies and ensure operational transparency.

The initiative integrates seamlessly with the company's existing infrastructure, drawing data from the Head-End Systems (HES), Meter Data Management System (MDMS), and other sources. The result is a dynamic system capable of real-time anomaly detection, offering SEC the ability to address issues proactively and optimize resource allocation across its distribution network.

How Was It Done? From Data to Insights: The Implementation Journey

The implementation of the Consumption Anomaly Detection system for the company was meticulously planned and executed, leveraging advanced AI/ML techniques to ensure high accuracy and scalability. The journey began with the integration of diverse data sources, including voltage, current, and consumption data from HES, along with events and alarms data and weather information. These datasets provided a rich foundation for the AI/ML models to identify and predict anomalies effectively.

The core of the system lies in its ability to learn from the past to predict the unexpected. Historical datasets spanning months were meticulously analyzed to establish robust baselines for normal and anomalous consumption behaviors.

By integrating voltage and current profiles, environmental factors such as temperature and humidity, and event-driven deviations, the AI model achieved unparalleled granularity in their insights.

An iterative training process was adopted to refine the model's accuracy. This included:

Advanced Feature Engineering

- Transforming raw data into powerful predictors, such as peak load hours, consumption variations by weather conditions, and event-triggered deviations.

Precision Validation

- Every iteration was fine-tuned against stringent performance benchmarks like precision, recall, and false-positive rates, ensuring reliable and actionable results.

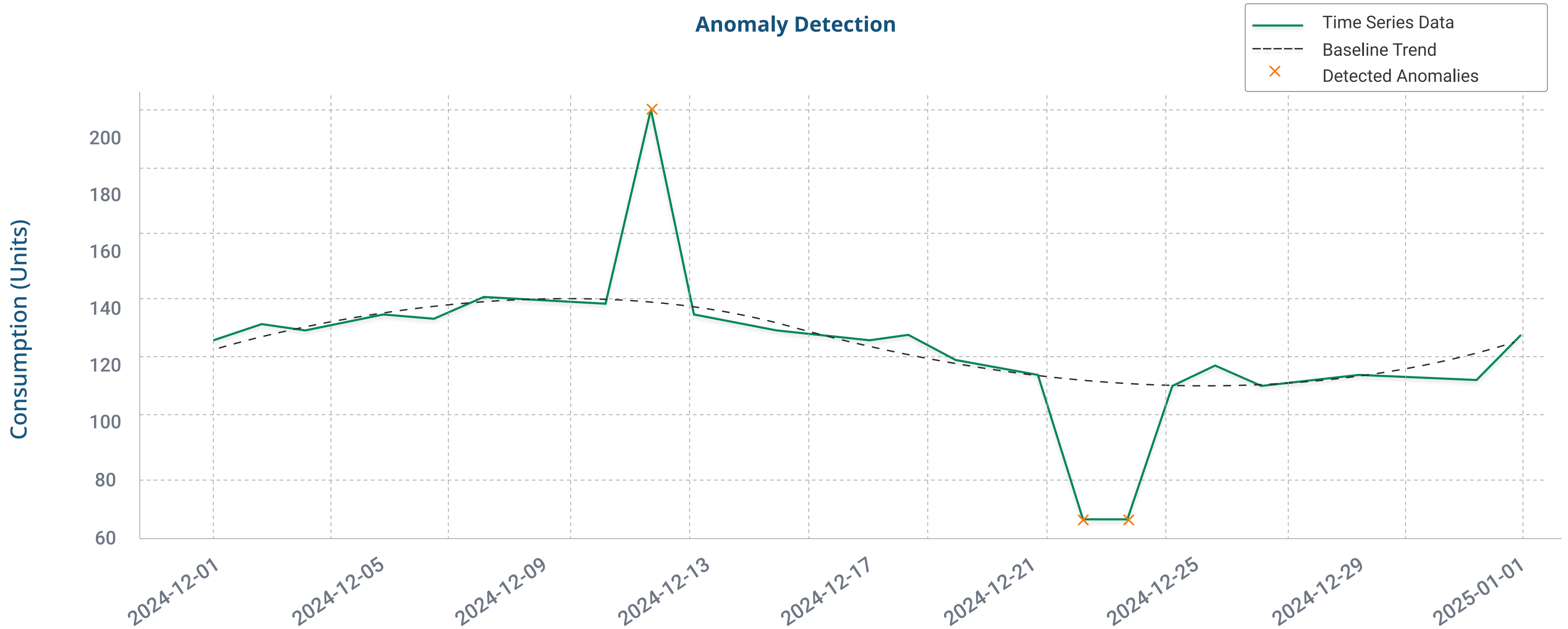
Adaptive Learning

- The models continuously recalibrate, leveraging field feedback (FFMS) to evolve with dynamic conditions, staying relevant and resilient over time.

The deployment phase focused on seamless integration with the company's operational workflows. Interactive dashboards provided intuitive visualizations, enabling field teams and decision-makers to respond swiftly and effectively. By incorporating AI/ML models trained on comprehensive datasets, the system achieved a high level of accuracy in detecting consumption anomalies, setting a benchmark for operational efficiency in utility management.

Impresa Solutions:

- Impresa Insights Platform
- Revenue Assurance Insights

Anomaly Detection**Business Outcomes**

The implementation of this solution delivered transformative outcomes for the company. By automating anomaly detection, the utility minimized revenue losses caused by Energy theft, Faulty meters or bad connections. The system's ability to detect and address discrepancies early ensured billing accuracy and improved customer trust.

Operational efficiency saw a significant boost as manual processes were replaced by AI-driven automation. This allowed the company to allocate resources more effectively, focusing on high-priority tasks rather than labor-intensive anomaly checks. Additionally, the actionable

insights provided by the system empowered the company to make informed decisions regarding grid optimization and resource planning.

From a customer perspective, the initiative strengthened transparency and accountability. Consumers benefitted from quicker issue resolution and more accurate billing, fostering stronger relationships between the companies and its customer base. The long-term benefits extended beyond immediate operational gains, positioning the company as a leader in adopting cutting-edge technology to meet the demands of modern energy management.

Summary

The Consumption Anomaly Detection initiative demonstrates the effective application of AI/ML in identifying and addressing consumption irregularities within the company's operations.

By improving operational efficiency and aligning with sustainability and customer satisfaction goals, the project establishes a foundation for future digital advancements. This initiative supports 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.**

