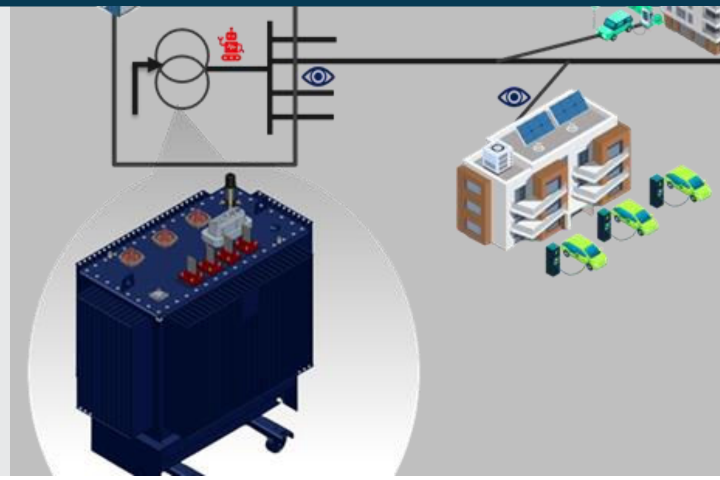
SUCCESS CASE 14.2024

i-TRAFO

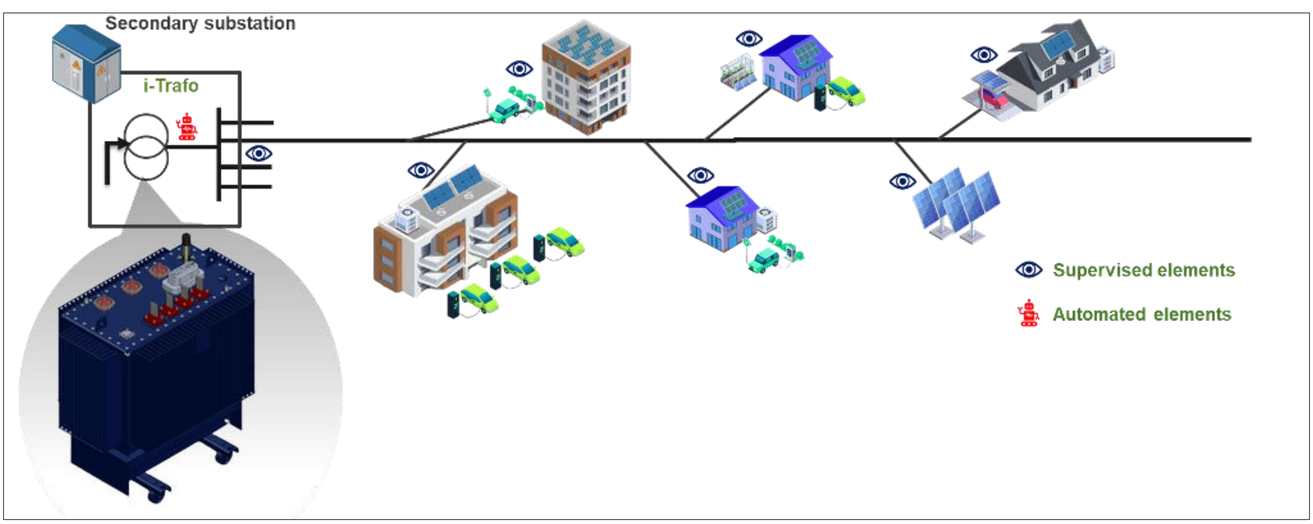
INTEGRATION OF OLTC TRANSFORMERS INTO THE LOW VOLTAGE GRID



THE CHALLENGE

Current problems in the field of quality of electricity supply are closely related to compliance with standards, such as the IEC 61000-4-30, which establishes **voltage thresholds** that must be respected both by consumers and generators connected to the low voltage (LV) network. According to the EN50160 standard, DSOs in Spain have the responsibility of maintaining the voltage within a range of ±7% of its nominal value. This requirement guarantees the **reliability and quality of electricity supply** for end users.

Voltage restrictions can be aggravated by the integration of electric vehicles (EV) and distributed energy resources (DER) as these can cause unpredictable voltage fluctuations that complicate the control of the voltage level to the end customers and, therefore, maintain the limits established by local regulations. The **on-load tap changer (OLTC) transformer** can play a relevant role in achieving **dynamic adaptation of the voltage to fluctuations in load, generation and power flows**.

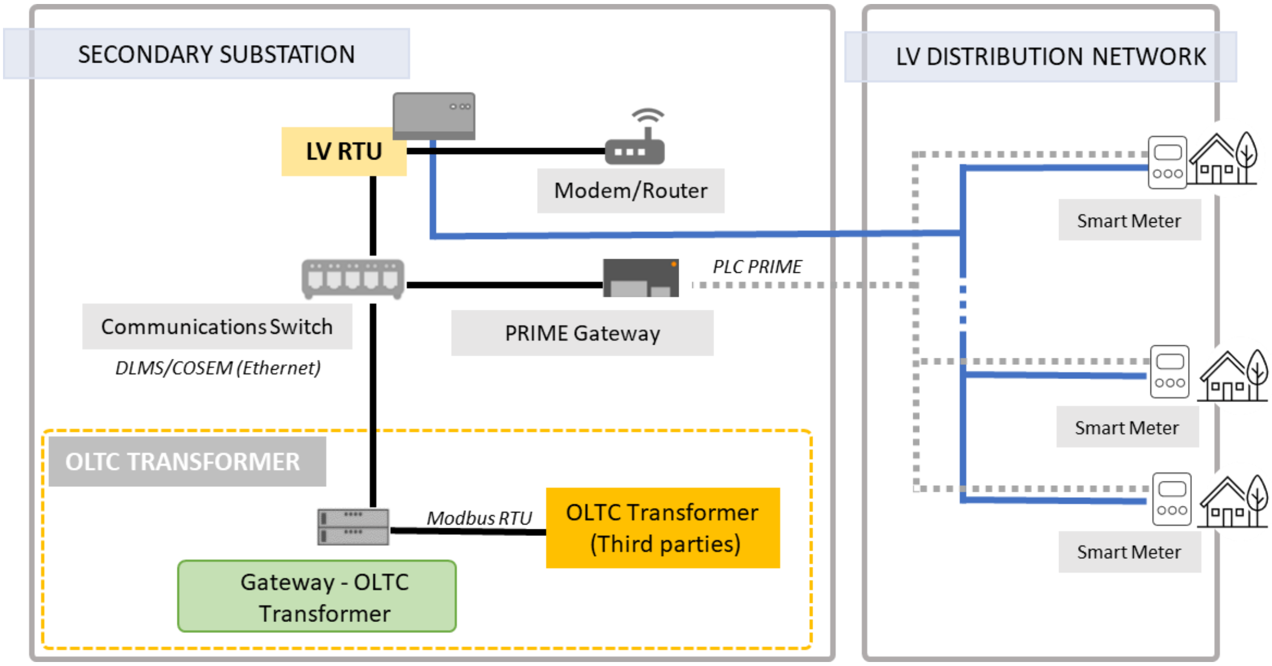


Smart Transformer (i-Trafo) in a secondary substation.

THE SOLUTION

The solution proposed by i-DE is based on an architecture centred on the secondary substation, where different LV supervision and/or automation solutions are located, all managed through a central element, called **low voltage remote terminal unit (LV RTU)** and based on market standards that allow for flexible, scalable and common operations.

This group of electronic and electromechanical devices are integrated using an Ethernet bus and controlled using the DLMS/COSEM protocol over TCP/IP (industry standards). The data obtained in real-time (e.g., electrical parameters, alarms and automation status) are sent to the DSO's SCADA/ADMS (Supervisory Control and Data Acquisition/Advanced Distribution Management System) using the IEC 60870-5-104 real-time protocol, although other protocols such as DNP3 or IEC 61850 could be used. The LV RTU acts as a communication master for all devices and communicates with the central management system of the DSO and/or the SCADA/ADMS using different communication technologies, such as API-REST.



General proposal for the type of architecture described above.

MAIN ADVANTAGES

The integration of EVs and DERs in LV systems poses challenges and opportunities in the management of the electricity grid. In this context, the use of LV OLTC transformers can have several important implications and advantages:

- **Flexibility and adaptability**: OLTC transformers offer the flexibility to adapt the voltage in the LV grid according to changing conditions, such as variable load due to EV charging and intermittent generation from DERs (e.g., photovoltaic (PV) generation). This allows maintaining optimal voltage in the network and guaranteeing the quality of supply.
- **Reduction of power losses**: OLTC transformers can help minimise power losses by adjusting the voltage to be as close to nominal as possible. This is particularly relevant in systems with high DER penetration, where distributed generation can vary significantly.
- **Grid voltage stability**: the integration of EVs and DERs can cause voltage fluctuations in the LV grid. OLTC transformers can mitigate these fluctuations and maintain voltage stability, which is essential to ensure the safe operation of electrical equipment and EV charging.
- **Improved EV Charging Management**: OLTC transformers can be used to manage EV charging efficiently. During peak charging hours, voltage adjustments can optimise charging capacity and reduce grid congestion.
- **Improved power quality**: OLTC transformers can help maintain better power quality by controlling voltage and reducing the presence of harmonics in the network. This is especially relevant when it comes to systems with high DER penetration, which often generate energy in an intermittent and variable way.
- **Efficient infrastructure investment**: Integrating EVs and DERs into LV systems may require infrastructure investments, including OLTC transformers and advanced control systems. These investments, necessary to guarantee efficient and reliable operation of the network, represent a much more cost-efficient solution compared to other traditional solutions.

KEY SUCCESS FACTORS

OLTC transformers play a crucial role in LV grid management in a context of increasing integration of EVs and DERs. Their ability to adjust the voltage in real time and maintain grid stability is essential to ensure efficient and reliable operation of the electrical system in these changing circumstances. However, their effective implementation requires **careful planning**, optimising both resources and costs, and **collaboration between stakeholders** in the transition to a more sustainable and modern electricity system.