elewit

# I. Challenge Title

Continuous monitoring systems for contaminating SF6 by-products in high voltage equipment of the Electricity Transmission Grid.

# II. Needs

SF6 is a widely used gas in the electricity industry due to its great electrical insulation capacity. This gas is present in many high-voltage components, mainly switches (both insulated with air and with SF6) and enclosures of the rest of the live elements and switchgear of GIS substations (gas insulated switchgear), where it is present in considerable quantities, usually with absolute pressure of 7 bars, but it can reach up to 9 bars. Maintaining this insulating gas in optimal conditions below certain limits of impurities is essential for the proper functioning of the network.

The current procedure to analyse impurities in SF6 requires the uploading of the equipment (shutting down the facility) and taking samples to be analysed.

The need identified is to develop efficient systems (technically and financially) to monitor the contaminating by-products of the SF6 present in these elements on demand and with the equipment available, without needing any discharge, in order to prevent untimely failures in the insulation, resulting in incidents in the network or potentially dangerous situations for the personnel working in the above-mentioned facilities.

# III. Description of the Challenge

As previously stated, throughout its useful life this SF6 present in the facilities can gradually degrade due to contamination of other compounds that are inherently originated due to its use and thus lose its insulating properties, while serious failures may occur in the correct functioning of the network, as well as dangers for the safety of the people who must work in the surroundings of said facilities. In addition, due to gas leaks in the enclosures containing the gas, or misconduct during the filling process, humidity can appear, and when it is high, the degenerative process of the gas also accelerates, affecting the state of the metals, causing possible oxidation.

This degradation is due to events inherent to the operation of the electricity transmission grid, both planned (e.g. controlled opening/closing of switches for the operation of the system and to carry out maintenance work on the network), as well as unplanned events and phenomena (e.g. short circuits, partial discharges, bad contacts between elements...). Depending on the intensity, repeatability and root cause of the event, various by-products derived from this degradation and decomposition of SF6 can be generated.

Therefore, one of the most promising ways to monitor the quality of insulation in these facilities is through the monitoring of these decomposition products, with technical documentation available in this regard. Among others:

- https://www.redalyc.org/articulo.oa?id=46725267004
- https://standards.iteh.ai/catalog/standards/iec/74c9c6d3-8dda-4b43-bb18-8a441433eca4/iec-60480-2019

The present challenge is to analyse and propose viable and efficient solutions, technically and financially, to continuously monitor the polluting elements present in SF6.

Within the technical aspects, it should be noted that the proposed solution must not require a modification in the design of the high voltage switchgear or compromise the functionality of the gas, so the solution cannot be invasive and must respect the internal volumes and pressures of

the compartments containing the gas, as well as the high temperatures that can be reached in small traces of the gas as a result of the energy transmitted to it; only sight glasses, valves, covers, density meters or similar elements may be used to house the proposed sensor system.

Another important technical aspect to highlight is that the solution must be suitable to function in a very demanding work environment in terms of pressure, high magnetic field gradients, the possibility of over voltages, high temperatures, and the like... (those of a high voltage facility of 400 or 220 kV). All this combined with limited space availability due to equipment design limitations.

# IV. Impact

The solution developed should decisively contribute to improve the reliability of the electricity transmission grid by monitoring the state of the SF6 insulation, which will anticipate possible failures of the facilities and the development of better maintenance strategies resulting in the improvement in the availability and useful life of the equipment as well as saving the company money.

Therefore, it is essential that the proposed solution not only detects anomalies in the insulation, but also provides information allowing the root cause of the anomaly to be described as accurately as possible in a reliable and selective way (which may result in the detection of more than one component).

# V. Evaluation Criteria

### MATURITY OF THE PROPOSED SOLUTION AND TIME-TO-MARKET

The degree of initial development of the proposed solution will be assessed as well as the estimated investment and resources necessary to bring it to commercial maturity.

### IMPLEMENTATION SIMPLICITY

The simplicity of implementation and the lesser degree of modification necessary to design those elements that house the sensor will be highly valued (respecting the above-mentioned limitations.)

### FUNCIONALITY PROVIDED

The functionalities provided by the solution will be evaluated from the technical point of view, which include:

- Sensitivity in detection (in ppm of the different compounds)
- Selectivity in detection (that there is no interference with other elements or with the SF6 itself)
- Number of compounds detected
- Sensor operating range (probability of saturation, reproducibility of measurements, etc.)
- Reliability
- Estimated useful life
- Robustness
- Minimum maintainability requirements
- Others…

### INNOVATIVE NATURE

The innovative nature of the proposal will be valued

### SCALABILITY OF THE SOLUTION

The amount of equipment to be monitored in the transmission grid with the proposed system is potentially large, so the scalability of the costs of the proposed system constitutes a decisive aspect.

By way of illustration: at REE we have about 30,000 potentially monitorable compartments, of which 13,000 correspond to switches (priority equipment to monitor)

### WORK TEAM

The experience of the work team in the field of investigation of this challenge will be valued.

### DOCUMENTATION

The potential of the proposal should be properly justified based on the information available.