NEXT ENERGY CHALLENGE

CHALLENGE 1

Grupo Energía Bogotá and Redeia Seek solutions for SF6 leak repair and containment in electrical installations

An Initiative to Promote Innovation and Sustainability

Introduction

Grupo Energía Bogotá (GEB) is a leading energy company in Latin America, operating across electricity and gas generation, transmission, and distribution. Its commitment to sustainability and innovation has been instrumental in developing projects that promote energy efficiency and emission reductions. The company manages assets valued at over $20 billion and operates in more than six countries.

Redeia, a Spanish company with operations in Latin America, specialises in managing and operating critical infrastructure, primarily power grids. As it has a strong focus on sustainability, it is dedicated to integrating renewable energy sources and enhancing the security and efficiency of electricity supply. The company controls more than 44,000 km of electricity transmission circuits in Spain; it also coordinates the operation of the country's electricity system. Furthermore, Redeia manages electricity assets in Chile, Peru, and Brazil.

Sulphur hexafluoride (SF_6) is widely used in the electricity industry due to its excellent insulating and arc extinguishing properties. However, SF_6 is also a potent greenhouse gas, with a global warming potential (GWP) 23,500 times greater than that of carbon dioxide (CO_2) over a 100-year period. This makes SF_6 a significant concern for climate change, particularly amid global efforts to reduce GHG emissions and mitigate environmental impact.

In this context, proper management of SF_6 in electrical installations—especially in gas-insulated sub-stations (GIS), which contain substantial volumes of this gas—has become a priority for business and regulators in the industry. To foster innovation and the implementation of effective, sustainable solutions, a competition has been launched to identify and reward the best proposals in this area.

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Characteristics of SF_6 electrical installations

SF_6-based electrical installations stand out for their high efficiency and operational reliability. Thanks to its exceptional dielectric properties and arc extinguishing capability, SF_6 enables the construction of compact, lightweight equipment. This results in significant savings of space and resources.

These installations include advanced containment systems to prevent SF_6 leaks into the environment. These systems typically feature hermetically sealed enclosures for live components, equipped with safety valves and monitoring systems to detect any potential leaks. Additionally, materials used in these systems are carefully selected for their resistance to corrosion and wear, ensuring a long service life and minimal maintenance. However, leaks into the atmosphere can occur due to potential wear, deterioration, and defects in containment components. Another reason causing leaks is the fact that SF_6 is maintained at high pressures (ranging from 4 to 10 bar, depending on equipment design and voltage levels).

Purpose of the Challenge

It is essential for SF_6 installations to have rigorous maintenance protocols and technological solutions for early leak detection. They must also count on containment systems that minimise gas emissions into the atmosphere until the installation can be taken offline for a thorough repair. An effective solution would include a robust and automated real-time monitoring system for gas levels, potential system failures, and, in the event of leaks, the volume lost.

Through this challenge, GEB and Redeia aim to gather innovative proposals for solutions such as methodologies, materials, sensors, and manufacturing techniques for reliable, effective, versatile, rapidly deployable, and cost-efficient leak detection and containment.

Use Cases

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1 Leak Detection Methods

Once a leak is detected in an installation containing SF_6, operational constraints may result in significant delays (weeks or even months) before the installation can be taken offline long enough to perform a permanent repair or replace the components causing the leak.

Therefore, solutions are sought to provide easily adaptable methods and systems for leak containment. These must address diverse porosities and joint types with potential leaks. They must also be quickly manufactured, supplied, and installed to contain leaks within days or a few weeks of the repair request.

Requirements

Solutions and methods are needed to implement leak-tight systems for SF_6 containment. These systems must be easily adaptable to accommodate various types of leaks. They must also include a sealing mechanism capable of absorbing material expansion and contraction in GIS installations, as well as the vibrations occurring during maneuvers, operations, and other activities. The containment systems should be installed directly at the exact leak points, whether stemming from material porosities, joint flanges between compartments, or sealing surfaces between GIS components. The solution should create a sealed cavity or an enclosure that confines and contains the leak, preventing the emission of SF_6 into the environment.

The installation of such systems must be feasible without dismantling GIS compartments or performing subsequent high-voltage (HV) testing. Whenever possible, the systems should also allow for installation without evacuating the SF_6 inside the GIS, thereby eliminating the need for a discharge at the intervention site.

The ability to contain the leak as quickly as possible—and always within a timeframe not exceeding three weeks from the repair request—is highly valued. Consequently, it is necessary to have leak containment methods and systems that are easily adaptable to the diversity of potential leaks, as well as systems that can be rapidly manufactured, supplied, and installed to minimise containment time.

In conclusion, containment systems must meet the following requirements:

Adaptability and versatility:
Systems must be capable of adapting to the shape of various porosities and joint types.

Effectiveness:
Containment solutions must effectively control leaks, minimising environmental and operational impacts.

Speed:
Installation must be rapid, ideally within days or weeks.

Cost-effectiveness:
Solutions must be economically viable in both manufacturing and supply.

Industrialisation:
Containment methods should be suitable for industrialisation. Proposals with limited commercial maturity will be evaluated for their scalability and the reliability of services supporting their

implementation.

2 Leak Detection Methods

Definition

GIS sub-stations consist of numerous compartments confining SF_6 (typically dozens per installation), each equipped with measurement and monitoring systems such as density meters to track SF_6 levels.

Although hybrid density meters exist, which feature digital outputs enabling continuous remote monitoring, most of them currently in use are analogue and lack remote management capabilities. As a result, potential anomalies or leaks in the installation are detected through in-person inspections and manual readings of these devices. However, these readings are occasional and often fail to capture trends and evolutions in the measurements, which could help predict future issues.

The replacement of traditional analogue density meters with hybrid ones is expected to proceed slowly due to their cost, which is approximately €1,000 per unit, including connectivity (noting that a single sub-station can have dozens of these sensors).

This challenge seeks solutions for detecting SF_6 leaks through alternative methods to those described above. These methods must be effective, economically efficient, and capable of detecting leaks early, providing information about the volume of gas leaked, while facilitating the identification of the area where the leaking component is located.

Requirements

In the past, methods for detecting SF_6 particles in the air have been tested—many of these sub-stations are located indoors, making this task non-trivial due to the following challenges:

The concentrations of this gas are extremely low, making it difficult to ensure its flow through detection

A leak rate could be considered unusual if the SF_6 mass exceeds 0.5% annually of the total SF_6 volume in the sub-station.