Photonics21 Press Release

Scientists tap Underground Internet Cables to Fight Air Pollution and Predict Volcanic Blasts

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European scientists are building a vast environmental sensing network by adding light-based sensors to underground internet cables that stretch more than five billion kilometres around the world. The upgraded infrastructure will detect toxic gases and provide early warnings for natural disasters, such as volcanic eruptions and tsunamis.

A new €3.5 million project funded by the European Commission and supported by the Photonics Partnership is set to transform how we confront some of society's biggest challenges – from urban air pollution and industrial safety to early warnings of natural disasters.

The initiative, known as GASPOF (Pervasive Gas Sensing Using Optical Fibres), harnesses Europe's underground fibre-optic networks to detect Greenhouse and hazardous gasses like carbon dioxide methane, carbon monoxide and sulphur dioxide – while also monitoring temperature vibrations, and seismic activity that could signal events like volcanic eruptions.

While current fibre-optic cables can, in certain cases, detect physical changes like heat or tremors passing through them, they've never been able to sense chemical changes in the environment accurately at the scale and in the integrated way that GASPOF is aiming to achieve. GASPOF seeks to change that by integrating advanced optical spectroscopy with new sensing nodes, enabling real-time gas detection and environmental monitoring without interrupting the data traffic these cables already carry.

Project coordinator Alessandro Giusti, who leads the consortium of scientists and engineers, said: "Imagine a city's fibre backbone not just moving data, but constantly checking the air we breathe, the safety of industrial zones, and even the emissions from distant volcanoes. With GASPOF, we're using what's already in the ground to turn existing telecom networks into smart, pervasive environmental guardians.

"This is one of the first projects in the world to combine real-time gas detection and physical sensing directly within live telecom fibre networks, marking a breakthrough in how digital infrastructure can be repurposed for environmental protection."

To do this, the project will combine two cutting-edge sensing techniques – laser-based photoacoustic spectroscopy (PTS) and Laser Heterodyne Radiometry (LHR) – alongside coherent optical time-domain reflectometry (OTDR). Together, these methods will detect toxic and greenhouse gases directly along the fibre network, enabling fast, large-scale environmental monitoring.

Four Real-World Trials

To prove the concept, GASPOF will test its technology in four real-world scenarios throughout Europe:

- **Greenhouse Gas Monitoring in Cities** – The GASPOF team will provide vital greenhouse gas monitoring in cities such as Barcelona (Spain) and Thessaloniki (Greece), with plans to expand to other major urban centres across Europe, including cities in Italy, France, and Germany, where air quality and climate change monitoring are crucial for future sustainability.

- **Indoor Air Quality** – In places like the Sense City climate chamber in France, GASPOF will deploy its near-infrared and mid-infrared sensing technology to monitor pollutants linked to millions of premature deaths annually.

- **Volcanic Gas and Seismic Monitoring** – On the Canary Islands, the project will combine gas detection with vibration and thermal data to improve safety for populations living in volcanic zones.

- **Pipeline Safety and Leak Detection** – In Greece, the project will monitor natural gas pipelines for methane leaks – reducing economic losses and cutting potent greenhouse gas emissions.

Each of the four test cases addresses a distinct challenge, such as climate action, public health, industrial safety, and disaster preparedness, while sharing a common goal: transforming Europe's digital infrastructure into a pan-European early warning system for environmental threats.

"By piggybacking on the vast fibre networks already in place, we hope to make a cost-effective solution that avoids the need for additional sensors, power lines or maintenance. This low-impact approach is especially critical in places that are hard to reach, like volcanic slopes or underwater cables," said Giusti.

"The scientific challenge is formidable. Integrating gas sensing nodes into telecom fibres without disrupting data transmission requires balancing precision, cost and compatibility. The project is also exploring how to standardise these innovations so that they can be scaled up and adopted across industries and national borders."

GASPOF is set to conclude in 2028 with a total budget of nearly €3.5 million and an impressive line-up of European partners. Led by the Cyprus Research and Innovation Center (CY.R.I.C.), the consortium brings together leading research institutions, universities and industry players from across the continent: ADTRAN Networks in Germany, Université Gustave Eiffel in France, Universidad Carlos III de Madrid, TU Wien in Austria, Universitat Autònoma de Barcelona, and Spain's national research council CSIC, as well as Greek network operator LANCOM.

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