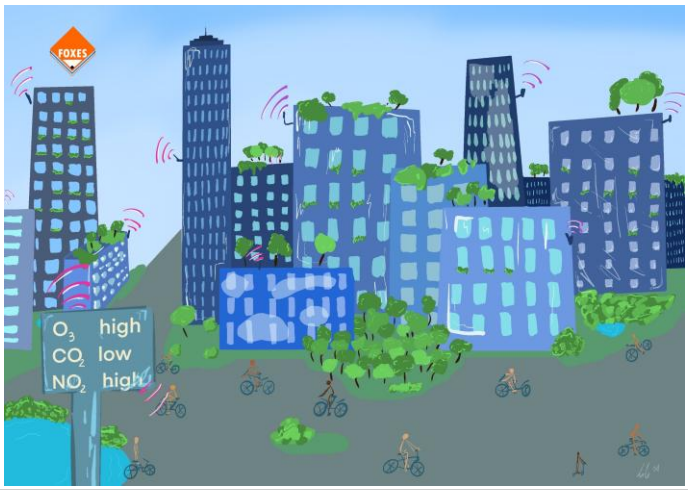
SUCCESS STORY

IC-MPPE
Integrated Computational Materials Process and Product Engineering.

Programme: COMET – Competence Centers for Excellent Technologies

Programme Line: FETPROACT-EIC-05-2019 - FET Proactive

Project: FOXES - Fully Oxide-based Zero-Emission and Portable Energy Supply, 2020-2025



Comprehensive environmental monitoring in cities using the energy-autonomous FOXES sensor system. Image: MCL (Liliane Plöschberger)

ENERGY-AUTONOMOUS SENSOR SYSTEM FOR ENVIRONMENTAL MONITORING

COMPREHENSIVE ENVIRONMENTAL MONITORING. AN ENERGY-AUTONOMOUS SENSOR SYSTEM IS BEING DEVELOPED AT MATERIALS CENTER LEOBEN.

Air quality in our environment has a major impact on our health. Especially in cities, air is heavily polluted by vehicle exhaust and other emissions. While air quality is currently monitored at specific points using stationary measurement systems, there is no truly comprehensive monitoring that provides a complete picture of pollution levels. Achieving this requires a large number of miniaturized gas sensors distributed throughout urban areas, continuously measuring air quality to create a full coverage map.

These sensors, however, should not require a wired power supply because they need to be energy-autonomous. This makes it possible to deploy large numbers of sensors as part of an Internet of Things (IoT) network across a city, enabling widespread air quality monitoring. The sensors automatically connect with each other, link to the internet, and provide real-time data.

As part of the FOXES project, Materials Center Leoben (MCL), acting as consortium leader, worked together with four partners from Germany, Spain, and Portugal to develop a sensor system that integrates both energy generation and storage, making it fully energy-autonomous. Organic solar cells developed by the University of Wuppertal, with contributions from AMO GmbH, are used for power generation. This energy is stored in supercapacitors developed by MCL based on perovskite materials. These capacitors supply power to a gas sensor developed by the University of Barcelona, which measures ozone and

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nitrogen oxides even at night. UNINOVA contributed highly efficient electronics to ensure optimal interaction between all components and to transmit measurement data to the cloud. The result is a fully functional energy-autonomous demonstrator, initially tested extensively under laboratory conditions. Following these tests, the system was deployed at multiple locations across the city of Barcelona, where it was successfully evaluated under real-world operating conditions and varying lighting environments.

Deployment of the energy-autonomous FOXES sensor system above the rooftops of Barcelona.
Image: University of Barcelona

The FOXES project has demonstrated that energy-autonomous sensor systems can already be successfully deployed today.

Impacts and Potential Applications

The energy-autonomous sensor system developed within the FOXES project can now be deployed anywhere as a scalable, IoT-enabled sensor network. Instead of isolated measurements, this network enables comprehensive environmental monitoring across entire urban areas. The collected data is centrally processed and made available to users via smartphone apps. This allows individuals to assess air pollution levels in real time and avoid highly polluted streets. At the same time, public institutions such as city governments can respond immediately and implement countermeasures.

This newly developed sensor system provides a foundation for future research and environmental monitoring projects in urban environments.

Project Coordination (Story)
Dr. Larissa Egger
Senior Scientist Sensor Solutions
Materials Center Leoben Forschung GmbH
T: +43 (0) 3842 45922 – 631
larissa.egger@mcl.at

IC-MPPE / COMET-Zentrum
Materials Center Leoben Forschung GmbH
Vordernberger Straße 12
8700 Leoben
T +43 (0) 3842 45922-0
mclburo@mcl.at
www.mcl.at

Project Partners

- Materials Center Leoben Forschung GmbH, Austria
- Universidad de Barcelona Spain
- Universität Wuppertal, Germany
- UNINOVA, Portugal
- AMO GmbH, Aachen, Germany

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