CO2 under surveillance

Switzerland is to gain a dense, globally unique CO2 measuring network:   
300 sensors permanently collect up-to-date readings, which form the basis   
for atmospheric dispersion models that are being developed at Empa.

TEXT: Martina Peter, Michael Lieberherr / PICTURES: Empa / Google Maps

With the Paris Agreement in 2015, the international community made a commitment to reduce global greenhouse gas emissions. Meanwhile (and despite the recent US pull-out by “El Donaldo”), over 190 nations have ratified the agreement. Individual cities have set themselves even more ambitious targets. What is currently lacking, though, are the right tools to measure progress – such as one that enables up-to-the-minute measurements of CO2 levels.

The Carbosense project is creating new possibilities in this respect. Soon, 300 CO2 sensors scattered all over Switzerland will be in use to convey their data in real time via the Internet of Things. So far, there were only a handful of places throughout the country for measuring CO2 . This new dense, globally unique sensor network records spatial and temporal changes in CO2 levels in the atmosphere. As project leader Lukas Emmenegger, head of Empa’s Laboratory for Air Pollution/Environmental Technology, explains: “The CO2 sensor network will be a valuable springboard that will allow us to better understand the natural and manmade sources and drains of CO2 in Switzerland.”

The x-ray machine for CO2

For the City of Zurich, where the sensor network will be particularly close-knit, Empa developed a computer model that simulates the CO2 concentration from ten different sources (see diagram). These emission sources include various kinds of traffic, industry or heating systems in residential buildings, for instance. By combining these simulations with the sensor data, Empa will be able to display the city’s current CO2 emissions practically in real time. “This will give us readings with a sufficient density to follow Zurich’s CO2 emissions virtually live,” says Emmenegger. “What’s more, the measurements will provide valuable information on the spread of other air pollutants.”

The scientific and technical applications based on this sensor data recorded all over Switzerland, on the other hand, will give valuable hints for traffic planning, healthcare measures, developments linked to “smart cities”, and even for a better understanding of the exchange of CO2 between the atmosphere and the vegetation.

Swisscom is installing the CO2 sensors at antenna sites. The 300 battery-powered sensors transmit their readings to the computing centers at the ETH Domain’s Swiss Data Science Center (SDSC) via Swisscom’s Low Power Network, which offers a narrow bandwidth but has a long range, transmits in an energy-saving manner and reduces network costs. This makes it just the ticket for linking up environmental sensors, parking spaces, containers or any other communal infrastructure.

Not only does science stand to benefit from the sensor network, but also the Low Power Network itself: the sensors scattered across the country are a good way to continuously assess network quality. Carbosense, a collaboration between Empa, SDSC, the Empa spin-off Decentlab and Swisscom, was initiated by Empa and Swisscom and is co-funded by nano-tera.ch. //

The Empa spin-off Decentlab

300 measuring devices scattered across Switzerland form the backbone of a CO2 sensor network. Empa spin-off Decentlab integrated CO2, temperature and moisture sensors along with a communication module for LoRaWAN (Long Range Wide Area Network) in a device and caters for the wireless, low-energy mediation of the data to the next gateway. These gateways are connected via the internet to Decentlab’s cloud and visualization infrastructure. Empa scientists can access the data directly and are currently evaluating the data: depending on the time of day, the CO2 values measured can be distorted by temperature and moisture. Thanks to new mathematical sensor models, however, these deviations can be corrected and losses of individual data packets can be “bridged”.

Pictures

This new dense, globally unique sensor network records spatial and temporal changes in CO2 levels in the atmosphere as well as moisture and tempeature. All data are accessible from a web platform.

The distribution of the CO2 concentration in the City of Zurich averaged over 2013 and 2014. Thanks to the readings from the sensor network, this

kind of model calculation will be more precise in future.