Air Quality 2

All three of them clearly understood the urgency of committing to the fight against air pollution and improving the air we breathe.

And indeed, their actions and innovations are or will be deployed at various sites and they are working with us.

Hello to you first, Romain Dénin.

Hello.

You are the co-founder of Bioteos, a biotechnology startup based in Willem in the Hauts-de-France region.

We are also joined by Antonia Oug, hello.

Hello.

You are the CSR Director of the Keolis group, and finally Mathieu Gobi, thank you for joining us.

Hello.

General Manager of Aérophil who will tell us about ParAPM, which is a fine particle capture device.

First question, to start with you Romain Dénin, what is Bioteos? What do you make?

Actually Bioteos is a young startup; we created it in June 2021 with my partner and today what we do is purify air with microscopic algae.

I even brought a small sample; we did this in the metro, we installed an air purifier that uses microalgae.

Is this an experiment?

Exactly, it was an experiment carried out with Keolis services who helped us integrate our solution into the station environment.

So how does it work? We obviously saw that they were microalgae, we can't see them—they are microscopic.

How do they work? What do they do to purify metro air?

So what happens is first we draw in the air and put it in contact with water that contains the microalgae.

The polluted air passes into the water, the pollutants dissolve in the water, and at that point the microalgae consume them and the air that exits is purer.

Okay, so the microalgae feed on fine particles?

They don't feed on fine particles; they mainly consume gases like NOx, VOCs, and CO2. As for fine particles, what happens is that the particles adhere to the microalgae's cell membrane and then form flocs that settle to the bottom.

So you can slightly see at the bottom of the solution the microalgae that have fallen because they absorbed fine particles.

A floc is a kind of aggregate of fine particles and microalgae?

Yes, and microalgae.

How long has this existed?

You said 2021 — when did the experiment start?

It started in March, we finished it in July and now we are waiting for the results because we did this in partnership with Atmo France, an association that makes air quality sensors and will produce a report by the end of the year to demonstrate the effectiveness of the solution.

When did you realize that microalgae could be interesting to "eat" pollution?

Well, my partner and I have been thinking about microalgae for about five years, so we began to consider what to do with microscopic algae and we saw many scientific papers, particularly about the ability of microalgae to capture pollutants like CO2. Digging deeper, we discovered they could capture other pollutants and also be effective on fine particles, for example.

What does the system look like?

I think it's a kind of large tube.

It’s actually a column of 2.30 m — a mobile urban column 2.30 m high, 80 cm wide — and we try to be very visual to show what we do. Yes, so you can see through the microalgae.

You can’t see it that way in the metro, though — the solution we make now for offices lets you see the microalgae.

But we really try to show people what we do because air is completely abstract and if we don’t show people that we are acting on air quality, we lose them when we say we installed a solution but it’s invisible.

So we try to communicate about that.

We spoke earlier in the program: pollution is somewhat more present in the metro. Is that why you chose that location?

Exactly. From the start of the project we contacted the Lille Metropolis to talk about installing an air purifier in the metro.

How does that work? Is your solution for a particular stop? Is the air cleaner there?

That’s why we run tests. We know a single machine won’t be effective for an entire station. Our goal is to purify air locally, for instance on a platform.

On a platform you would need at least two to really purify the air?

To really purify the air, yes. We will purify the air locally where people wait for the metro. That’s where people are most exposed to air pollution because trains arrive and people wait one or two minutes.

We spoke a bit with Keolis and Antonia Hug, Group CSR Director. Why was it important for you to participate in this experiment with Bioteos?

As transport professionals, we naturally have both a moral and a conviction-based imperative to be involved in this issue — for our customers and our employees and to support the local ecosystem to nurture local solutions. It's a topic that exists in every country, in every metro, but working locally can lead to further joint projects.

Is it an important issue for a group like yours, which is obviously a world leader in passenger transport, to address the impact of air pollution?

Yes, of course. I think it was mentioned earlier: there are really three levers. First, measure — understand where pollution is and in what quantities.

There are protocols to set up: you must look at certain locations, according to ridership and time of day, whether it's underground or not. That's the first step for us, to then be able to take action accordingly. We focus particularly on the metro, but it's also a background issue when we work on buses — type of propulsion and fuel.

We'll discuss that because you're doing many things on buses and in the metro. Keolis carries out many different actions.

I'd also like to introduce Mathieu Gobbi, General Manager of Aérofil ParAPM. You invented the device that captures fine particles. How does it work and how did your project start?

It started with the Generali balloon we flew in the 15th arrondissement. At Aérofil we construct that balloon; it carries passengers in Paris in partnership with Airparis and CNRS. We decided to turn the gondola into a true flying laboratory since the balloon produces no pollution; it's an ideal platform to raise awareness. We equipped it with instruments to measure pollution during the flight, so we see concentrations and how they change with altitude, which gives interesting information about atmospheric chemistry.

Is air more polluted at altitude?

No, usually air is cleaner at altitude because denser particles fall. They have weight, and weather conditions also matter. For example, winter concentrations can produce smog — a fog that traps pollutants at ground level — so with our balloon we see concentrations drop when we rise. We suspected this but can now observe it precisely with the balloon.

We've been measuring for eight years, learning about atmospheric pollution and its health impacts. It's through the balloon that we identified the most energy-efficient way to capture fine particles because the balloon itself attracts particles by an electrostatic effect.

That discovery was somewhat accidental; it wasn't expected initially. We asked why the balloon gets so blackened and realised an electrostatic phenomenon was at work. Particles can be captured as if by a magnet using an electric field. We replicated that in our ParAPM system to capture fine particles.

We simply pass air through a nozzle and charge particles at the inlet with a very strong electric field. We collect them on metal plates and clean them once or twice a year. This uses very little energy because we don't use a mechanical filter; it's just an electric field acting on the particles, so with little energy we can treat a very large volume such as entire metro stations, train stations and even outdoor spaces. To understand how ParAPM works: it draws in polluted air and outputs purer, filtered air.

Exactly — it's like a fountain of clean air. You suck in ambient air on one side and expel perfectly clean air on the other, at about one cubic metre per second. So we can clean a very large volume.

When and where will you deploy it? Have you already run an experiment?

We have a prototype proven in a lab and several pilot sites: an industrial site (a factory) and a library. It may seem odd, but these are large volumes we want to clean. In both cases the locations are enclosed. Filtering outdoor air is not feasible; spaces are always semi-enclosed with ventilation because people need fresh air to avoid CO2 buildup. For a large volume you need a high flow device to clean it. So we have the library and we also now have a metro station in Lyon, and I believe you'll also come to Paris in 2024.

In parallel, we were selected in a tender by Solidéo, the company responsible for delivering Olympic works, to equip the athletes' village in Saint-Denis. We will outfit an entire square with a device that will clean the air across that space.

Is the innovation to filter air and improve air quality recent, or is there a real awareness today driving such innovation to reduce air pollution?

I think what is recent is awareness of the health impact of fine particles — they cause cancer, strokes; for a long time people thought they only irritated airways. Today we know they are very harmful. Standards are being set to reduce the concentrations the population is exposed to.

Antonia, you obviously work with metropolitan areas. Do you also feel an increased, more structured awareness among your clients?

Our clients are the people who use the metro, but we work with transport authorities. For example in London's metro, it's not closed, but we will work with the local authority on this subject. These authorities have clearly asked in recent years for improved air quality. The issue has always existed but awareness is accelerating and there is willingness to allocate resources and collaborate.

When we talk about innovation, it seems both Bioteos and ParAPM are relatively small devices placed in restricted areas. Could these be scaled up?

In both cases these are experiments: for now it's a device in a station to see local effects. If we duplicate them and deploy dozens or hundreds of devices we could depollute an entire metro network, but we won't clean an entire city. It's about reducing exposures and focusing on the places that need it most — where people are present and sensitive, like schools and particularly polluted sites. Unfortunately, underground places are poorly ventilated: metros and parking lots. Many locations would benefit from cleaner air for the people who pass through or work there.

Antonia, you strongly support innovation within Keolis. Does that mean you can help deploy solutions elsewhere?

Yes — that's the advantage of having a large, even international footprint: we can replicate what works while ensuring local presence to work not only with large companies but also where innovation happens.

The Metropolitan Authority fully funds the installations and the local team handled setup. Is large-scale installation feasible for Bioteos?

It would be conceivable, but first we are waiting for Atmo France's report. Then we will submit it to the MEL and await a potential call for tenders from the MEL to capture air pollution.

Do systems that clean air already exist?

Yes, systems already clean indoor air in hospitals and clean rooms; we can achieve perfectly pure air. Today the ambition is to clean public air, not necessarily to reach clean-room standards, but to find the right balance and set realistic ambitions. For example, our metro measures often show particle concentrations two to three times higher than outdoor ambient air. So if we can reduce concentrations in the metro by half, we will have achieved something almost sufficient, since people breathe outside air afterward. What's new is the desire to develop this at scale with adapted ambitions.

You mentioned an open innovation approach and local ecosystems. What does that mean concretely?

It means we also work with universities, like in Rennes and Bordeaux. In Rennes, we will install sensors on buses to monitor pollution. Romain Dénin, could your system be used inside a bus?

Miniaturising our system will be complicated. We currently need a liquid medium. We are researching ways to avoid the liquid medium, but for now we still require a certain space. Innovation in capturing air pollution and fine particles is at a very early stage, but it's developing and resources are being invested. I'm sure there will be significant progress for the benefit of users.

We will certainly talk about this again. Thank you all three for joining us on the Fréquences Communes set. I wish you a very good day and see you soon.

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