Wind tunnel begins operations

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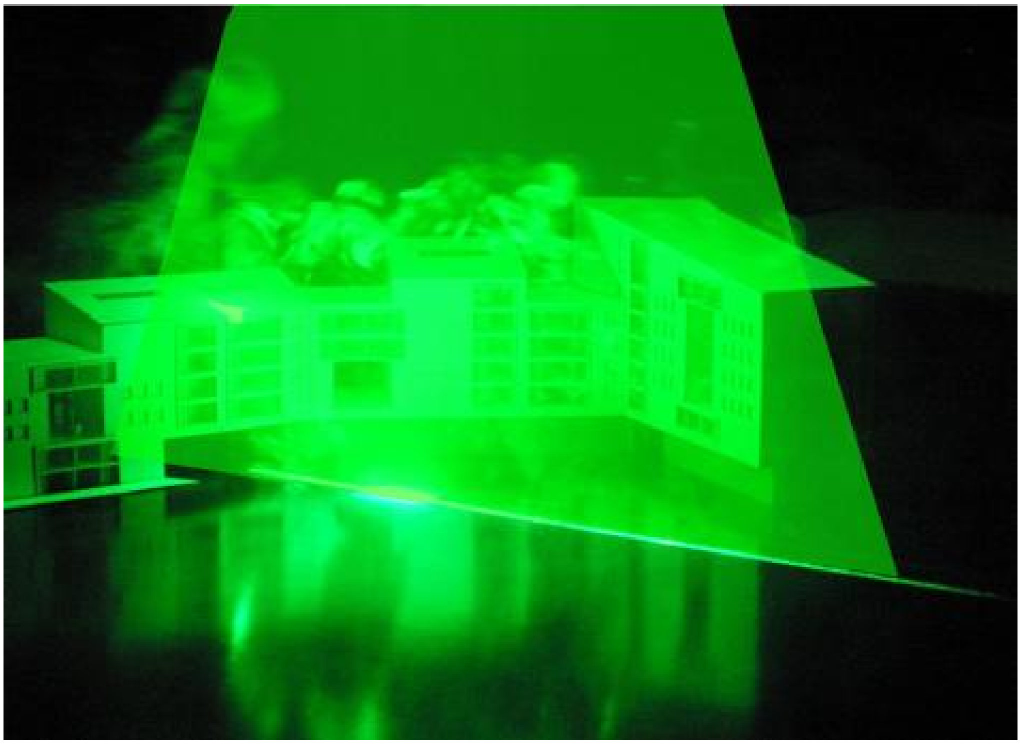
Working on the wind tunnel operated by Empa and the ETH.

On hot days it is often very still in cities because the high density of buildings prevents the air from circulating freely. In the newly commissioned wind tunnel operated by Empa and the ETH Zurich wind effects and thermal situations in towns and cities can be simulated and various scenarios tested, with the aim of improving urban climate in a natural way.

A typical city: row upon row of houses built almost on top of each other, with asphalted roads between them and with very few green areas to be found. Urban areas built on this pattern warm up more strongly than their rural surroundings, creating islands of warmth. The waste heat emitted by vehicles and machinery (such as air conditioning equipment) causes yet more heating, and even during the night the city hardly cools down to any noticeable extent. Megacities such as Mexico City and urban conurbations such as Athens are more and more frequently covered by a visible dome of pollution because the air cannot properly circulate. This kind of this urban climate can damage the health of the city's inhabitants because the concentration of trapped pollutants may reach dangerous levels.

Built-up areas in cities do not automatically lead to still air conditions. An example of this is Chicago, which is nicknamed "the Windy City" because, being located on the shores of Lake Michigan, it is cooled even during the hottest summers by a pleasant breeze. This only happened, however, when the streets were laid out in a grid pattern as the city was rebuilt after the great fire of 1871, allowing the onshore breeze from the lake to blow freely through the street "canyons" between skyscrapers.



A model building illuminated with a sheet of laser light.

Using models to check architectural measures

The new wind tunnel, which Empa, together with the ETH Zürich, has had constructed is 26 m long and about 4 m high. In it, scientists will be able to test simulations of ideas for improving the "airing" of cities, on a scale ranging from 1 to 50 to 1 to 300. A ventilator with a diameter of 1.8 m powered by a 110kW electric motor will blast air at up to 90 kilometers per hour through the tunnel. The aim of the researchers is not to generate the highest possible wind velocities (such as would be necessary to test building façades). Rather, they plan to investigate how air masses circulate around buildings, what velocities winds can reach, when does turbulence occur and what effects does all this have in terms of energy, comfort and health. They would also like to know such things as whether houses can be cooled by the wind alone in summer (free of charge!), where draughts and windy conditions might cause problems – for example in street cafes – and whether pollutants can be transported away from cities by natural means.

Laser technology makes wind speeds visible and measurable

In contrast to computer simulations, in which results are obtained purely by calculation and suffer corresponding levels of uncertainty, the wind tunnel allows scientists to make accurate physical measurements. This enables them to verify simulations and then fine tune them, an important factor for researchers.

The Empa system boasts another advantage over its "contemporaries" – its sophisticated measuring instrumentation, which includes two high-speed cameras and a special high-performance laser. Whereas in other wind tunnels air mass movements must be inferred from a set of single measurements made at specific individual locations, "… we can make the air currents visible almost in real time, even with all their fluctuations and turbulence," says Victor Dorer, the Empa scientist responsible for the wind tunnel. In order to make the airflow “visible” to the two high-speed cameras, tiny particles are injected into it. A sophisticated dosing system ensures that these particles are evenly distributed in the current and they are then lit up by a special laser which produces a sheet of light. Pictures taken at millisecond intervals make the movements of the particles visible.

The data is then analyzed on the computer. Processing and evaluating the thousand images which are taken every second requires a great deal of computing power. The result looks like a film and enables the user to visualize the air currents. The way the air flow develops, including both large turbulence zones and small eddies, can be seen on the computer screen and velocities are indicated by various colors.

The results are very useful, for example, to architects, urban climate planners, air hygienists, building engineers, and the developers and users of air current calculation programs or software for analyzing the energy usage of buildings. They can also be used to evaluate the effects which wind turbines have on each other.

Provided by Empa

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