CO_2

by Sergio Ramazzotti

parallelozero

ITALY, TURIN

At its laboratories, the Italian Institute of Technology conducts large-scale experiments to monitor, mineralize, and molecularly break down CO2. Here, an engineer prepares a large-scale model of an offshore oil platform to simulate the diffusion of emissions from hydrocarbon extraction into the atmosphere. On the left, an underwater drone, also developed at the Italian Institute of Technology, which, with its three months of navigation range, allows to collect and analyze in real time samples of marine waters to assess the concentration of climate-changing substances such as CO2, responsible for ocean acidification.

A MATTER OF LIFE *AND* DEATH

It's the gas that's been spoken about more than any other in recent years, and it's the one that we instinctively associate with climate change. It is for this reason that it's generally perceived negatively. However, it actually forms the basis for nature's lifecycle, as well as that of human beings, and despite its many uses in industry and in our daily lives, some well-known, others less so, we no longer pay much attention to these aspects.

It is, however, a fact that the planet is in danger of being destroyed by the very gas that – together with oxygen – has thus far contributed to keeping it alive. Over the period between 2008 and 2018, CO2 emissions increased by 12% as a direct result of human activity. A NASA study has shown how the level of CO2 in the Earth's atmosphere, which until recently had essentially remained stable below 300 parts per million for the past 800,000 years, has rapidly increased since the middle of the last century, registering 310 parts per million in 1950 and rising to 410 today. In its 2021 ranking of global threats, Axa Insurance put climate change back in first place, followed by hacking, while Covid, after two years in the top position, slipped to third. Reducing emissions to contain global warming and the devastating consequences that ensue has become absolutely imperative, but it's a goal that doesn't align with a number of heavily conflicting factors such as overpopulation, the ever-increasing demand for energy, incipient urbanization (it's estimated that seven-tenths of the world's population will live in megacities by 2050), and the steady increase in the volume of transportation.

These are factors which, on paper at least, make the goals of the Paris Agreement seem unattainable. Only on paper though, because, when we talk about reducing emissions, we usually think in terms of the simple need to stop producing CO2. That’s an unrealistic prospect: as Bill Gates explains in his latest book *How to Avoid a Climate Disaster*, "There are no realistic paths to zero that involve abandoning fossil fuels completely or stopping all the other activities that also produce greenhouse gases.” Yet research, particularly in Italy, is making enormous strides towards developing techniques for capturing carbon dioxide from the air, for storing it, but above all for recycling it intelligently: using mineralization or biofixation with microalgae to obtain products such as polymers, cement or flour, which are reusable in construction, cosmetics and food products, or by means of molecular recomposition in substances that can also be reused with zero impact, such as synthetic methane.

John Kerry, the US special envoy for climate, said in 2021 that at least 50% of the cuts in emissions needed to achieve carbon neutrality in time will come from "technologies that have not yet been invented". And it's this that offers us the most promising path towards neutralizing the so-called unavoidable emissions, which the energy transition process, at least until it’s completed, will not be able to contain alone.

ITALY, MILAN

On October 1, 2021, Swedish activist Greta Thunberg (center) joined about 50 thousand students who demonstrated for the climate during the Fridays for Future initiative. In those days the city hosted the Pre-Cop26 meetings, preparatory to the Glasgow Conference of the Parties on the climate emergency.

ITALY, FERRARA

The exhaust chimneys of the so-called Polo Chimico, or Chemical Pole, a complex established in the late 1930s, within which there are many companies in the chemical sector, such as producers of plastics, polypropylene, elastomers and nitrogen-based fertilizers. According to estimates by the IPCC, the United Nations Intergovernmental Panel on Climate Change, the industrial sector is responsible for 21% of global CO2 emissions.

SWITZERLAND, GENEVA

At the CERN, among the thousands of pipes and lines surrounding the Atlas experiment within the underground LHC (large hadron collider), some belong to the CO2-based cooling system. The electronic detectors and calorimeters used to monitor subatomic particles in the Atlas experiment, where high levels of radiation are present during particle collisions, need to be kept at the constant temperature of -40° Celsius, thus a perfectly efficient and reliable cooling system is needed. In the past, CERN used a perfluorocarbon-based system, but in the past years it has turned to CO2, since it is environmentally friendly and it allows working with smaller-section pipes.

PORTUGAL, LISBON

A visitor at MAAT (Museum of Art, Architecture and Technology) interacts with "The CO2 Mixer" installation, created by Italian studio Dotdotdot and exhibited in the museum through 2021. The installation consists of a console with an animated graphic interface, which allows the visitor to calculate their personal energy impact on the Planet based on their lifestyle, showing how each daily activity – to each of which corresponds a cursor on the console – is responsible for a certain amount of CO2 emissions.

SWITZERLAND, HINWIL (ZURICH)

Swiss company Climeworks captures CO2 directly from the air and stores it in pressure tanks. The facility, built in 2017, was the world's first commercial-scale direct air capture plant and it is capable of capturing 900 tonnes of CO2 per year. From the tanks, the carbon dioxide is piped to a nearby greenhouse, where it is used to make the atmosphere suitable for crops, and to a bottling plant, where it is used to make carbonated drinks. Climeworks is also building similar plants in countries like Iceland, where CO2 captured from the air is instead stored directly underground.

LEADERS SUMMIT ON CLIMATE

On April 21, 2021, U.S. President Joe Biden convened the "Leaders Summit on Climate," which was held – with participants, among them Brazil's president Jair Bolsonaro, connected remotely due to restrictions imposed by the Covid pandemic – in symbolic conjunction with Earth Day, with the aim of reviving the effort of major economies to fight climate change. Shortly before, on February 19, just three months after former President Donald Trump's exit from the Paris accords, the U.S. had officially rejoined the climate treaty by binding itself back into compliance with its rules.

ITALY, EMILIA ROMAGNA

An intensive chicken farm in the region where most of these farms are concentrated. In Italy more than 500 million chickens are bred every year, almost all of which are destined for domestic consumption. Intensive livestock farming is one of the leading causes of CO2 emissions, and together with intensive agriculture and the subsequent deforestation, which is needed for the production of huge quantities of feed, weighs for 24% of global emissions.

PHILIPPINES, MANILA

An aerial view of the city, shrouded in clouds and a blanket of pollution (2011). The Philippines is one of the countries in the world with the highest population growth rate. Overpopulation, together with the phenomenon of incipient urbanization (the United Nations estimates that by 2050 70% of people on the planet will live in a megacity) and the exponential increase in energy demand, is considered one of the primary causes of excess global CO2 emissions.

ITALY, MONTE CIMONE (MODENA)

The observatory of Monte Cimone rises on the summit of the homonymous mountain, which with its 2165 meters is the highest relief of the northern Apennines. Inside the complex, obtained from a disused alpine hut, the CNR (National Research Council) and the Italian Air Force carry out a daily activity of air quality monitoring, including the percentage of CO2 in the atmosphere. The data collected are shared with the global monitoring network ICOS (Integrated Carbon Observation System). Here, an Air Force member in one of the rooms housing the air spectroscopy instrumentation.

ITALY, MILAN

A firefighter demonstrates the use of a CO2 extinguisher on a gas-fueled flame in the courtyard of the provincial command headquarters. Fire extinguishers are one of several large-scale uses of carbon dioxide.

ITALY, MILAN

At the Cozzi pool, freediving athlete Massimiliano Pampaloni trains to keep diaphragmatic contractions under control, a stimulus that the brain sends to the respiratory muscles when it perceives a condition of hypercapnia, characterized by an excessive accumulation of CO_2 in the blood. Carbon dioxide is a product of the body's metabolism and is normally expelled through the lungs.

ITALY, MONCALIERI (TURIN)

Italdesign, which was acquired by the Volkswagen Group, is one of the leading companies in the world for the realization of stylistic studies and engineering solutions in the automotive field. In its premises there is a roller bench for the analysis of exhaust gases – including carbon dioxide – of thermal engines. In detail, the pipes that convey the various gases to the analysis instrumentation. It is estimated that the transport sector is responsible for 14% of global CO2 emissions due to exhaust gases emitted by thermal engines.

ITALY, SICILY

An eruption of the volcano Etna, one of the most active in Europe, as well as the tallest. Volcanoes are a significant contributor to CO2 emissions, releasing between 130 and 230 million tons of CO2 into the atmosphere each year. However, this is less than 1% of the total carbon dioxide emissions caused by anthropogenic activities, which are around 27 billion tons per year.

ITALY, SUBBIANO (AREZZO)

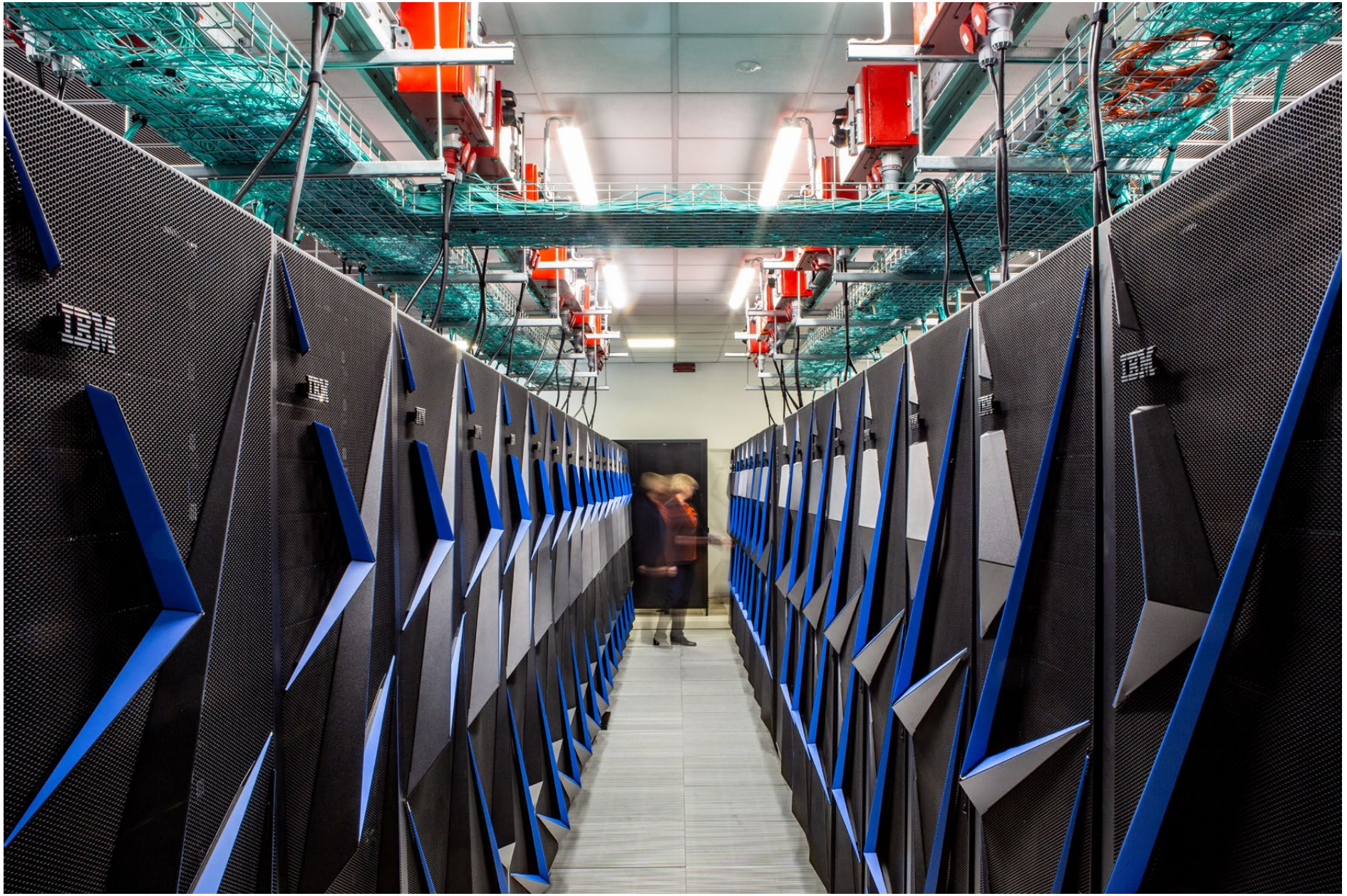
Locatelli Meccanica is one of the main Italian companies specialized in the production of dry ice, which is carbon dioxide solidified at a temperature of -78° Celsius. Dry ice has numerous uses, such as low environmental impact-refrigeration, transportation of medicines or vaccines to remote areas, or the creation of special effects.

ITALY, MONTE CIMONE (MODENA)

The observatory of Monte Cimone rises on the summit of the homonymous mountain, which with its 2165 meters is the highest relief of the northern Apennines. Inside the complex, obtained from a disused alpine hut, the CNR (National Research Council) and the Italian Air Force carry out a daily activity of air quality monitoring, including the percentage of CO2 in the atmosphere. The data collected are shared with the global monitoring network ICOS (Integrated Carbon Observation System). Access to the complex is through a long tunnel that starts from the lower slopes of the mountain.

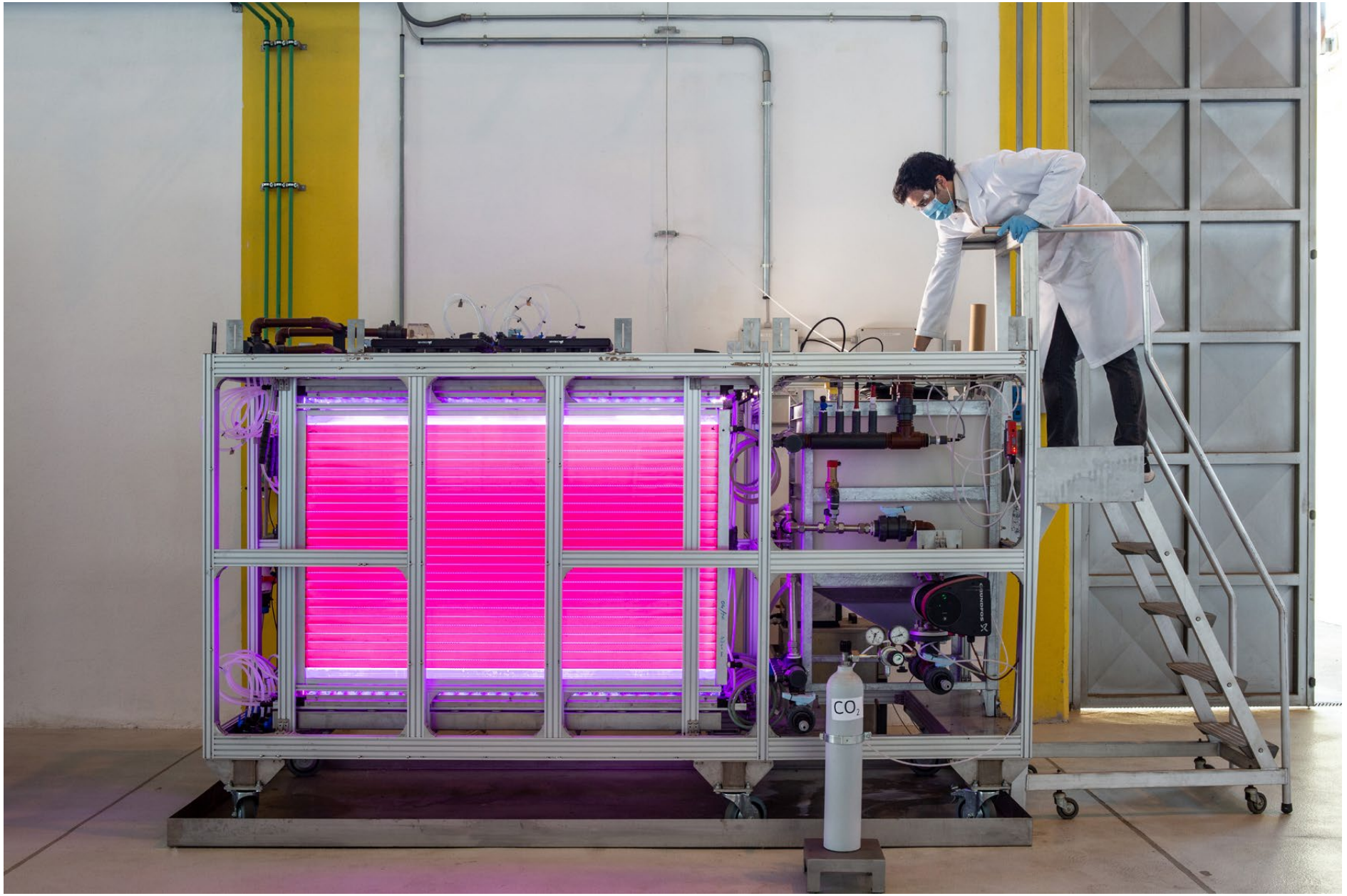
ITALY, LATERINA (AREZZO)

Itac is one of the main Italian companies for the production of CO2, which is extracted from wells drilled on the slopes of Mount Amiata, in whose subsurface there are large deposits of carbon dioxide of volcanic origin. After extraction, CO2 undergoes a gas chromatography process to ascertain its purity, then stored in large tanks or in cylinders for distribution in the food, industrial or medical sectors.



ITALY, BOLOGNA

Cineca is a computing center with one of the most powerful supercomputers in Europe. The center often collaborates with organizations such as Ecmwf, the European Centre for Medium-Range Weather Forecast, or Copernicus, the European Union's atmospheric monitoring program, which use supercomputing to perform simulations from large amounts of data collected from weather stations around the world.

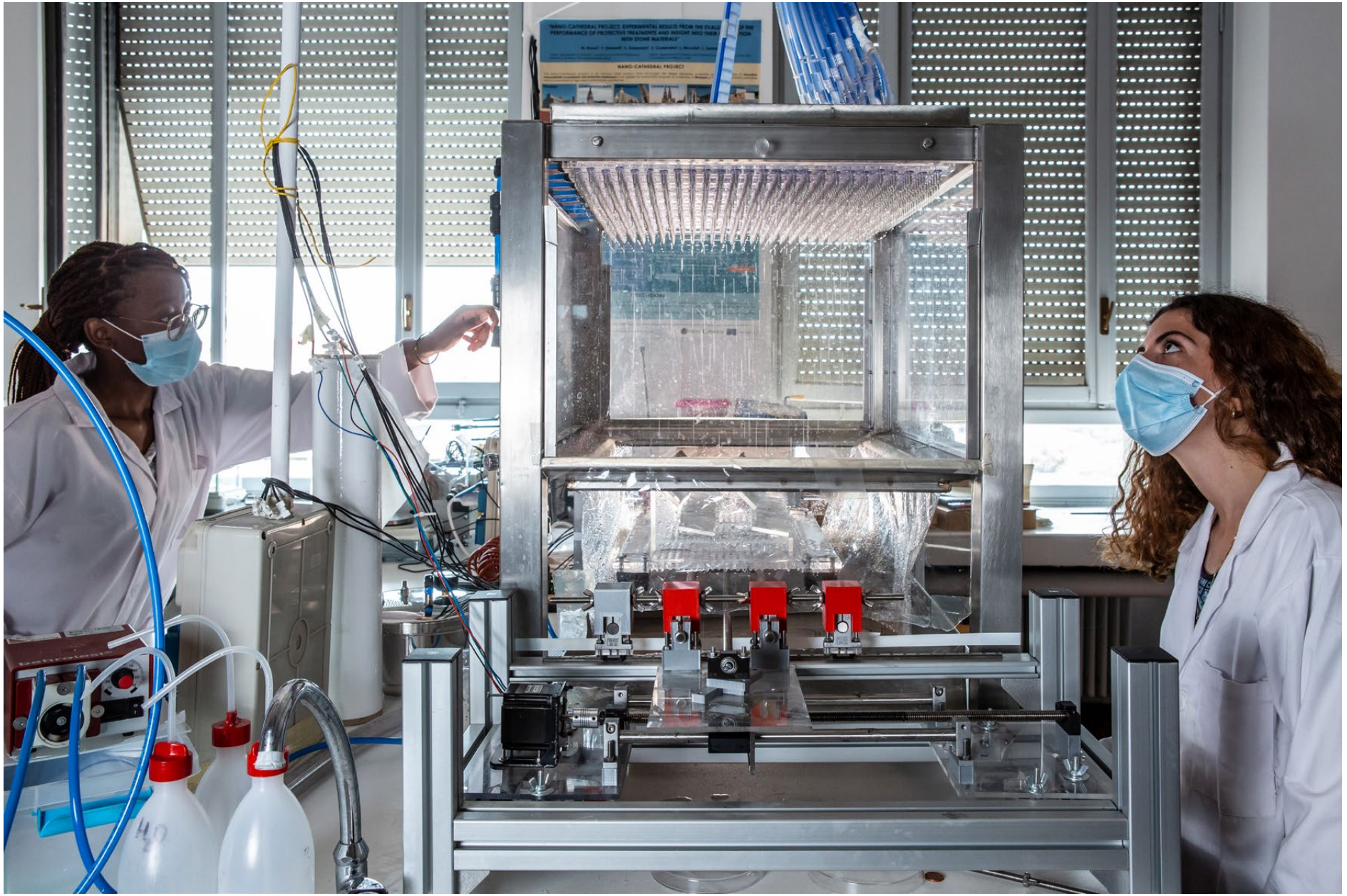


ITALY, NOVARA

At its Research, Technological Innovation, Renewable Energy, Environmental R & D and Process Technologies laboratories in Novara, the Italian oil giant Eni is conducting experiments to fine-tune the processes of CO2 biofixation using microalgae subjected to lights with different wavelengths. Vasco Di Castro, pictured here, is one of the engineers in charge of the project. The process produces algal flour and oil, which can be used in various sectors, such as the cosmetics industry or the production of biofuel.

KUWAIT, KUWAIT CITY

The main hall of the Stock Exchange (2012). The UN's Intergovernmental Panel on Climate Change (IPCC) estimates that fossil fuel extraction, refining and transport account for at least 10% of global emissions. Kuwait, one of the world's top oil producers, is also the country leading the global rankings for per capita emissions, with 50 tons per year of CO_2 per inhabitant.



ITALY, MILAN

Master students Attalian Mandebvu (left) and Giulia Nisticò check the prototype of a rain simulator machine built at the Department of Chemistry, Materials and Chemical Engineering at the Politecnico University. The machine is often used to simulate erosion on bronze, stone and other building materials provoked by acid rains, a direct consequence of the excess of CO2 and other climate-altering gases in the atmosphere. The Politecnico lab focuses on studies on materials and methods to preserve the cultural heritage.

ITALY, ASTI

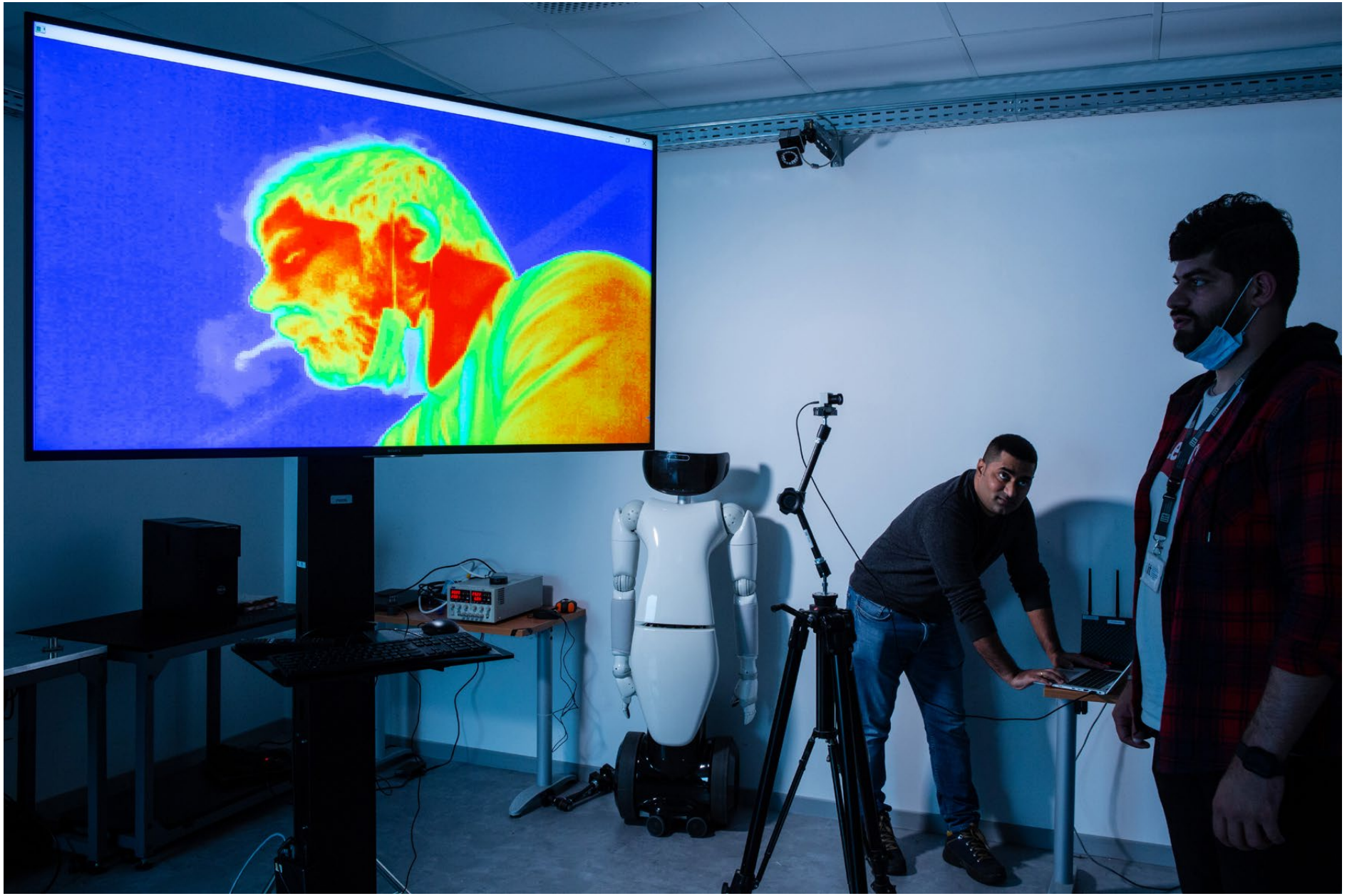
The exhaust chimney of a plasterboard factory in the countryside near Asti, in a UNESCO World Heritage area. According to estimates by the IPCC, the United Nations Intergovernmental Panel on Climate Change, the industrial sector is responsible for 21% of global CO2 emissions.

ITALY, TURIN

The seltzer siphon for carbonated beverages represents one of the most common and oldest domestic uses of carbon dioxide. In his house-museum in Turin, antiquarian and collector Paolo De Angelis has collected numerous examples of siphons produced mainly in the United States between the 1930s and 1950s, including a rare miniature travel siphon (on the table at right).

ITALY, SARDINIA

One of the most tangible consequences of excess CO2 and other climate-altering gases in the atmosphere are increasingly extreme weather events. In July 2021, a series of fires broke out in the Montiferru area of Sardinia. The fire, caused and made more difficult to tame also by drought and high temperatures, burned for days causing serious damage: more than 1500 people displaced from their homes, more than 20 thousand hectares of cultivated fields and olive groves destroyed. One of the symbols of this territory, a two-thousand year old olive tree nicknamed "*Sa Tanca Manna*", has also burned almost completely. Agronomists are trying to save it with a protective sheet and carefully dosed watering.



ITALY, GENOA

At the IIT (Italian Institute of Technology), researchers Seyed Saber Mohammadi (right) and Milind Gajanan Padalkar (center) demonstrate the use of an IR camera set to highlight the CO2 emitted by a human being during breathing.

ITALY, BERGAMO

In the first weeks of the Covid-19 pandemic in Italy, the city of Bergamo was hit hard, so hard that it recorded the highest per capita death toll in the world. The city's reference hospital, Papa Giovanni XXIII, risked collapse due to the high number of patients. Covid attacks the respiratory system and severely compromises the body's ability to dispose of excess CO2 through normal lung activity.

ITALY, TURIN

In its laboratories in Turin, the Italian Institute of Technology conducts large-scale experiments to monitor, mineralize, and molecularly break down CO2. In the chemistry lab, a detail of samples of polymers that can be made from carbon dioxide mineralization, and later used to replace materials such as plastics.

BRAZIL, SÃO PAULO

A commercial airplane aligned for takeoff on runway 17 at Congonhas airport. It is estimated that the transport sector is responsible for 14% of global CO2 emissions due to exhaust gases emitted by thermal engines. Commercial airplanes are one of the most significant factors in the sector and will continue to be so for a long time to come, as the technologies for converting jet engines into environmentally friendly engines, such as electric ones, are still a long way off.

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