Flow batteries charge ahead 35 Robert Perich: ETH Vice President steps down after 20 years 36 A profile of alumna Liliane Ableitner 45

# GLOBE

NO.
2 / 2023

FOCUS

## Water

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# EDITORIAL

"Water is existential."

Water shapes every facet of our world: it is an essential part of life, something we use daily, and sometimes a brutal force of nature. As a shared resource, it has the ability to both unite and divide us. ETH Zurich's research into water is as diverse as the element itself, spanning everything from the generation of hydropower to the ongoing effort to combat microplastic pollution in our lakes and rivers. Our labs are a hotbed of ideas for new start-ups – from creating an affordable water filter to harvesting drinking water from the air.

To advance its research in this field, ETH Zurich works closely not only with Eawag, the Swiss Federal Institute of Aquatic Science and Technology, but also with the Swiss Federal Institute for Forest, Snow and Landscape Research WSL, which are both part of the ETH Domain. Together, scientists from these institutes are taking a fresh look at how we manage wastewater. Meanwhile, climate researchers are busy addressing the big-picture questions, such as how heavier rainfall, longer droughts and melting glaciers interact with the global water cycle. In the process, they continue to refine their methods, increasing the resolution of climate models and thereby making them increasingly accurate.

I hope you enjoy reading this issue of *Globe*!

Joël Mesot,
President of ETH Zurich

*Globe* – the magazine for ETH Zurich and ETH Alumni

Images: Dan Cermak (cover page); Alexandra Compain-Tissier (editorial)

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Images: Daniel Winkler; Nicole Davidson

## NEW + NOTED



## FOCUS



## COMMUNITY



## REPORT



## PROFILE



**COVER** Water in its frozen state. From the photo series Water, created by Dan Cermak for *Globe*.

# NEW + NOTED

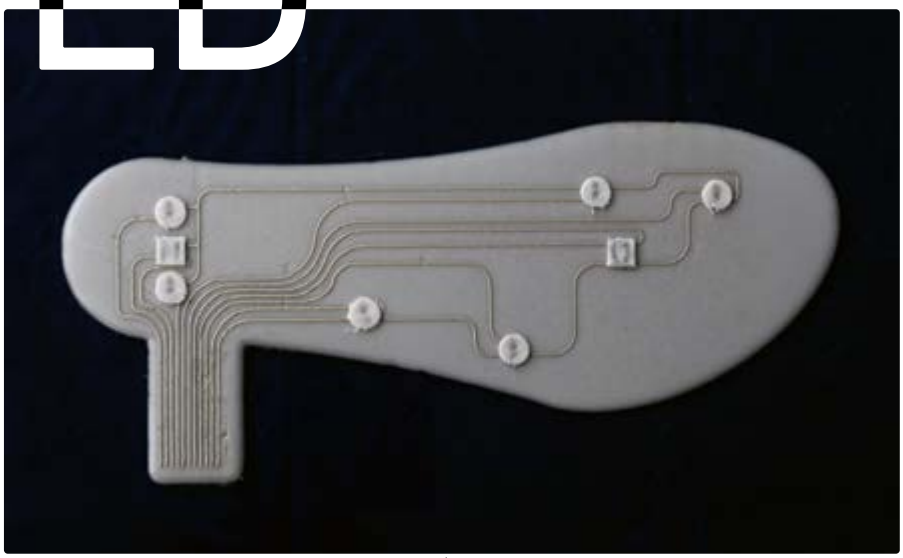


Image: ETH Zurich / Marco Binelli

Sensors and conductors are integrated into the insole during 3D printing.

## 3D-printed shoe insoles

Researchers from ETH Zurich, Empa and EPFL have developed a 3D-printed insole with integrated pressure sensors. The team used specially developed inks containing silver and carbon black to embed the sensors and conductors directly within the insole during the 3D printing process. Inserted in a shoe, the finished product can be used to measure the pressure on the sole of the foot. The researchers can even tell from the data whether someone is walking, running, climbing stairs or carrying a heavy load on their back.

In future, these insoles could be used by athletes to track their progress and fine-tune their training plans. The data could also be used to create custom-made insoles for permanent use.

The new 3D-printed insoles could also have therapeutic benefits. Currently, orthopaedists measure plantar pressure by asking patients to walk barefoot across a pressure-sensitive mat which records their characteristic footprint. With the 3D-printed insole, this can be done directly within the shoe while the patient performs different activities. Furthermore, the measurements are highly accurate. The resulting pressure profile can be used to produce customised orthopaedic insoles that offer targeted relief for musculoskeletal pain.

At present, the researchers still need a cable to read out the data, but they are aiming to develop an insole that features a wireless connection. ○

Video:
⟶ youtu.be/ACYedzZs7RU

# Why do forests turn brown?

Hot, dry summer weather is tough not only on people and animals but also on trees. During the past five years in European forests, spruce and beech trees in particular have been wilting and turning brown well before the end of summer – a clear sign of stress and diminishing vitality.

Researchers from ETH Zurich and the WSL systematically evaluated the impact of extreme summer weather conditions on Europe's forests between 2002 and 2022. Drawing on high-resolution satellite data, they found that summer browning has become more widespread across Europe, particularly over the past five years. The scorchingly hot summer of 2022 saw a record number of trees turn brown, with 37 percent of temperate and Mediterranean forest regions affected by the conditions.

The researchers also observed a measurable legacy effect – in other words, premature browning is not only caused by current weather conditions, but can also be intensified by periods of drought that occurred in previous months or years. Targeted monitoring of weather conditions over several seasons could therefore provide valuable insights into whether premature leaf discoloration is likely to occur the following summer. ○

Image: WSL/Valentin Queloz

Forest browning in the Swiss municipality of Courchavon in summer 2019, which was caused by repeated bouts of hot and/or dry weather.

# Cancer therapy with donor cells

The higher the number of immune cells attacking a tumour, the better the chance of recovery. Scientists are therefore looking for ways to provide patients with additional immune cells from healthy donors. Unfortunately, there is always a risk of donated cells triggering a severe or even fatal immune response in the recipient, which is why current immunotherapy treatments for cancer primarily rely on a patient's own immune cells. The problem is that these cells aren't always strong enough to attack the tumour. ETH researchers have now managed to engineer donor cells in such a way that they attack only tumour cells while leaving the cancer patient's healthy cells unscathed. In future, this new technology could make it possible to administer immune cells from any donor to any patient. Such a standardised solution would be both simpler and cheaper, meaning more patients could benefit. ○

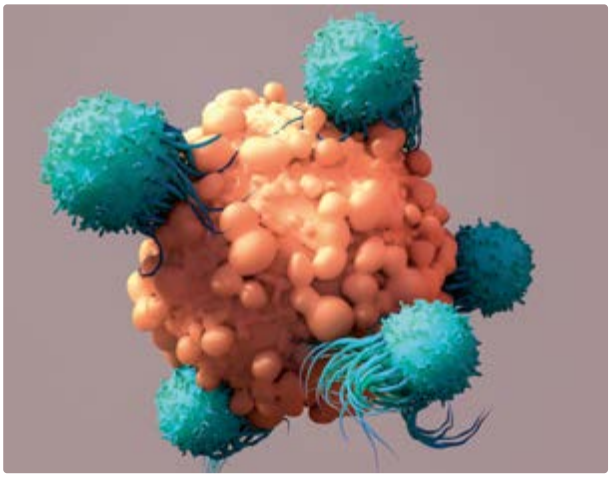


Illustration: Science Photo Library

The more immune cells (turquoise) attack cancer cells (orange), the better the chance of recovery.

Video:
⟶ youtu.be/ZQ6MQ4P0si0

Image: ETH Zurich/Matthias Hofer

# The great balancing act

It is now 10 years since a research group led by ETH professor Raffaello D'Andrea developed a cube-shaped robot that was capable of balancing on its own pivot and recovering its balance when nudged – it could also move and even jump. Now it has a successor – "One-Wheel Cubli" – which pulls off the same balancing act with just one reaction wheel. Acceleration of this wheel by means of an electric motor results in a reaction torque on the casing, which in turn stabilises the pendulum system. One-Wheel Cubli has two degrees of freedom: it can tilt from front to back or from side to side. On account of two masses attached at a distance from the centre, the inertia along one tilt axis is higher than along the other. As a result, the system moves faster in the direction of low inertia than in the direction where inertia is higher. Like a tightrope walker balancing by means of a long pole, the robot is therefore able to stabilise itself along both axes simultaneously – even if it is nudged. ○

Video of One-Wheel Cubli:
→ youtu.be/nEGe-VpyN3c

→ idsc.ethz.ch/research-dandrea

# New housing developments displace vulnerable people

Focusing exclusively on new housing developments to counter the housing crisis is not sustainable, says ETH professor David Kaufmann.

**DAVID KAUFMANN** is Professor of Spatial Development and Urban Policy at ETH Zurich.

Build, build, build is the dominant strategy to address the current housing shortage. In Zurich, the main focus is on densification, which means building more housing within settlements and existing urban boundaries rather than on greenfield sites outside the developed city.

Densification is necessary because we need new housing, and it also helps to protect undeveloped land and limit land uptake. In addition, it helps to reduce per capita carbon emissions by dampening the demand for mobility that is inevitably fuelled by increasing urban sprawl.

**UNWANTED EFFECTS** However, when I examined our analysis of several linked public datasets on buildings and households in the canton of Zurich, I was struck by how clearly it shows that current housing developments are pushing people out of their homes, and also out of the city. Shockingly, the adverse effects of today's profit-oriented housing developments turned out to be more severe than we and many other experts had thought.

Densification is primarily achieved by replacing existing buildings. In the canton of Zurich, a building is seven times more likely to be demolished and rebuilt than to follow the more environmentally friendly path of renovation or the addition of new storeys. Yet our analyses show that these new buildings are not only environmentally unsustainable; they actually displace vulnerable groups from city centres. By analysing all the multifamily residential units that were demolished or renovated in the canton of Zurich in the period between 2014 and 2019, we discovered that, on average, the people displaced by these projects had a monthly household income that was 4,800 Swiss francs below the median.

**WHO IS AFFECTED?** Specifically, people with African citizenship and temporarily admitted asylum seekers are three times more likely to be displaced, and single parents twice as likely. Is this really what we want from housing development and densification?

But it is not only new buildings that are the problem; renovations, too, can lead to social displacement. Those living in newly renovated apartments have an average monthly household income that is 3,623 Swiss francs higher than that of the people who lived there before. People displaced from Zurich city centre tend to move to the districts of Oerlikon or Schwamendingen, or to areas outside the city such as Regensdorf, Schlieren or Adliswil. Such involuntary displacement causes massive upheaval in people's lives. We all depend on relationships with people in our local community, and many of us also rely on local support services such as day nurseries, schools and home care. Displacement is particularly challenging for people in difficult

socio-economic situations, who then often face the daunting task of building new support networks from scratch.

**WHAT THE DATA MEANS** For the first time, our analyses provide concrete data on housing development and the displacement this causes. I do not believe that this data is saying that densification is a bad idea per se. But it does suggest that efforts to provide more housing should be underpinned by social and environmental measures. Densification should be accompanied by measures to ensure that vulnerable groups are better supported and protected by tenancy law.

Before demolishing old housing stock, we need to carefully consider its residual utility. Renovations should be implemented in stages so that residents have the chance to return to their homes. And cities and communes should do more to promote affordable housing – for example, by acquiring land and prioritising not-for-profit housing. In my view, this would help ensure that more people can afford to live in central locations – not just the well-off. It's up to policymakers and planners to act. ○

Read more blogposts at:
→ ethz.ch/zukunftsblog

David Kaufmann wrote this article together with Elena Lutz and Fiona Kauer.

Efforts to provide more housing should be accompanied by social and environmental regulations.

Images: provided: Keystone / Christian Beutler

# Detecting office stress

Image: Adobe Stock / Andrey Popov

The new model could enable employees to detect work-related stress early on.

Researchers at ETH Zurich have used machine learning to develop a new model for detecting stress levels at work based solely on the way people type or use a computer mouse. The model proved to be a better indicator of stress than measuring people's heart rate.

Neuromotor noise theory states that increased levels of stress negatively impact our brain's ability to process information and our motor skills. To verify this, the researchers observed 90 participants performing a variety of office tasks. Half the group were repeatedly interrupted with chat messages or were asked to take part in a job interview. Meanwhile, the control group was left to work undisturbed. As well as observing the participants' behaviour, the researchers also recorded their heart rates and regularly asked them how stressed they felt. They found that the people who felt stressed moved the mouse pointer more often and less precisely, made more mistakes when typing and tended to write in bursts, with many brief pauses.

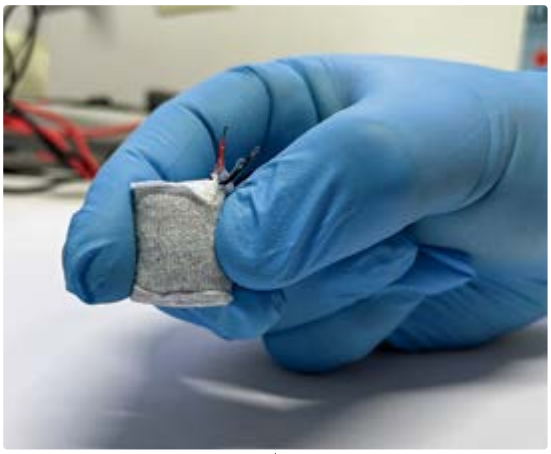
The researchers are currently testing their model on other Swiss employees. Their goal is to help people identify stress in the workplace at an early stage and thereby prevent it. ○

# Implantable energy supply

Pacemakers, insulin pumps and other medical devices that are worn on or in the body require a reliable source of energy. Typically, such devices are powered by single-use or rechargeable batteries. Now, ETH researchers have developed an implantable fuel cell that uses excess blood sugar (glucose) from tissue to generate electrical energy.

The new fuel cell could also be employed to treat diabetes. To demonstrate how this might work, the researchers connected the implanted fuel cell to a capsule containing artificial beta cells. An electrical current from the implant can then be used to stimulate these designer cells to produce and secrete insulin. The process works as follows: as soon as the implanted fuel cell detects excess glucose in the blood, it begins generating power. This electrical energy stimulates the artificial beta cells to produce insulin and release it into the blood. As a result, blood sugar returns to a normal level. Once it falls below a certain threshold, the production of electricity and insulin ceases. The fuel cell generates enough electrical energy not only to stimulate the designer cells, but also to enable the implanted system to communicate with external devices such as a smartphone. ○

Image: ETH Zurich / Fussenegger lab



Prototype of the fuel cell.

Image: Adobe Stock

Use of rapid tests was widespread during the coronavirus pandemic. Researchers now hope to make them even more reliable.

# Rapid tests made from graphene

Rapid tests have two big advantages over other forms of medical testing: they are easy to use and portable enough to take just about anywhere. Doubts can arise, however, when it comes to reading the result on the paper test strip. Now, a team of researchers from ETH has found a way to make rapid tests faster, more sensitive and more accurate. Using a laser, the team converted the cellulose in the paper test strip into graphene. Because graphene is conductive, they were able to incorporate electrodes directly within the paper itself. These trigger an electronic signal as soon as a target substance is detected, making the test results more reliable. ○

# WATER

FOCUS | This series of photographs was created for *Globe* by Dan Cermak. Inspired by Villa Hatt – ETH Zurich's guest house and event venue – the photographer turned an artistic eye to the element of water in all its myriad forms.

—〉 ethz.ch/villahatt

# A CONTESTED RESOURCE

The expansion of hydropower generation often leads to conflicts of interest, both in Switzerland and beyond. Researchers from ETH Zurich are trying to find a basis for compromise that serves the public interest.

TEXT Samuel Schlaefli

Without hydroelectric power, Switzerland would be a shadow of what it is today. The country generates some 60 percent of its electricity from a nationwide network of 1,500 run-of-river and storage hydropower plants – and their importance is only going to grow. "By 2050, electricity will make up between 38 and 46 percent of Switzerland's energy mix, which is a considerable jump from today's figure of 27 percent," says Robert Boes, Professor of Hydraulic Engineering at ETH Zurich. That's because a successful transition to renewables means replacing fossil fuels and electrifying more energy uses such as private transport. At the same time, Switzerland's last nuclear power plant is due to shut down in about ten years – so solar, wind and hydro will have to pick up the slack. The advantage of storage hydropower systems is their ability to store large amounts of energy over long periods of time, which is particularly important in winter when sunlight is less plentiful.

**EXPAND AND BUILD** "The fact that Switzerland can use water to store energy is a huge help when it comes to transitioning to a low carbon economy," says Boes. Over the past few years, his research group has carried out extensive research into the potential for expanding reservoirs in Switzerland and building new ones. In 2020, they calculated how much additional power could be produced if the capacity of 38 existing reservoirs in the Swiss Alps – each with a usable volume of at least 20 million cubic metres of water – were increased by 5, 10 or 20 percent. The researchers evaluated each reservoir's potential on the basis of eight criteria, including impacts on conservation areas and existing infrastructure and the ability to shift power generation to the critical winter period. They concluded that it would be possible to shift an additional 2.2 to 2.9 terawatt-hours (TWh) of electricity from summer to winter each year by expanding anywhere between 17 and 26 of the reservoirs on their list. Total winter hydropower generation would then rise from the current figure of 48 percent to as much as 62 percent of total annual hydropower production.

Boes' group also calculated the potential of constructing new reservoirs in 62 previously identified areas where glaciers are retreating. These areas, which were once home to large bodies of ice, will soon turn into natural lakes or empty expanses that can be used for reservoirs. "Within just ten years, for example, the Trift Glacier in the canton of Bern has retreated to such an extent that the lake could already be used to generate electricity," says Boes. Existing infrastructure tends to be minimal in the vicinity of newly formed glacial lakes, and →

in most cases, the areas freed from the ice are not protected. Boes' analysis came up with new hydro plants at the 12 most suitable locations after factoring in biotopes of national importance. These could produce between 1 and 1.2 TWh of electricity a year through natural flow and add a storage capacity of 1.4 to 1.5 TWh, taking into account existing plants in the downstream hydropower cascades.

The studies carried out by Boes' research group were high on the agenda of the Swiss government's Hydropower Round Table in August 2020, which brought together environmental organisations, hydro plant operators and cantonal and federal authorities. The participants discussed how to meet the goal of increasing winter power generation by 2 TWh by 2040, ultimately agreeing on a proposal to expand eleven existing reservoirs – including the Grimsel reservoir in the canton of Bern and Mattmark lake in the canton of Valais – and create four new ones. "At the core of the strategy is a potential reservoir near the Gorner Glacier, which could increase storage capacity by 650 gigawatt hours and annual generation by 200 gigawatt hours of energy a year," says Boes. "But building new reservoirs is a lot more controversial than expanding existing ones." Indeed, the Gorner proposal attracted plenty of criticism at the Round Table, with the Swiss Landscape Conservation Foundation refusing to sign the final declaration. One of their chief complaints was that the creation of the Gorner reservoir would have far-reaching consequences for one of the last unspoiled glacial mountains, which is listed in the Swiss Federal Inventory of Landscapes and Natural Monuments of National Importance. This is yet another example of how the expansion of hydropower always provokes conflicts of interest – however useful it may be as a mitigation strategy against climate change.

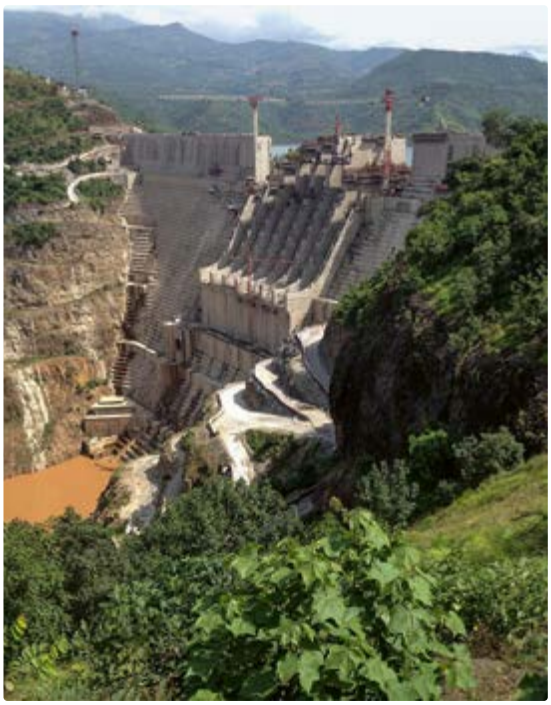


Image: Wikimedia Commons/Mimi Abebayehu

The Gibe III Dam on the Omo River in Ethiopia (2016)

"Hydropower projects also have an impact on local ecosystems."

Paolo Burlando

**BALANCING CONFLICTING INTERESTS** Someone who has spent years grappling with such conflicts of interest is Paolo Burlando, Professor of Hydrology and Water Resources Management at ETH Zurich. "Hydropower projects inevitably cause river fragmentation, which in turn has an impact on local ecosystems," he says. He cites an example from his own research in Zambia's Kafue Flats, a 240-kilometre-long and 50-kilometre-wide floodplain made up of swamp, open lagoon and seasonally inundated areas. During the rainy season, the floodplain receives water from the Kafue River, a tributary of the Zambezi River. It is an important habitat for antelope, zebras and hippos, as well as 450 endangered species of bird. Yet since the construction of two large dams in the 1970s, the frequency of flooding has diminished, with a correspondingly negative impact on biodiversity. So how do you weigh the need to generate power against the importance of protecting ecosystems?

To help answer such questions, Burlando and his team are devising mathematical models to facilitate a participatory and integrated management of water resources. Their hope is that simulating scenarios and providing a quantitative assessment of impacts could help to reduce conflicts between nature conservation, electricity production, the use of

water for agricultural purposes and the exploitation of water for industrial activities. The EU's DAFNE project proved to be a perfect opportunity to put the models to the test: with the help of 13 research partners from Europe and Africa – as well as regional authorities and hydropower plant operators – Burlando was able to apply one of his models to two concrete case studies: the drainage basin of the Zambezi River in southern Africa and that of the Omo-Turkana River basin on the Ethiopia-Kenya border. Key variables used in the model included the revenues of hydropower companies and the security of the electricity supply, the amount of water available for agricultural use, the devitations from the natural flooding of fragile ecosystems and the implications for the availability of drinking water. The simulations also addressed the expected impact of climate change. In the case of the Zambezi, the researchers were able to show that electricity production could be increased by 20 percent simply by improving coordination between the countries' dam operators – without any additional negative impact on the ecosystems.

For the second case study in the Omo-Turkana basin, the DAFNE team turned their attention to a complex political situation. Ethiopia has built three dams on the Omo River in recent years and has planned to use the water for large-scale sugar cane cultivation in the southern regions of the basin. The Omo is the only major river that feeds Lake Turkana. Located almost entirely within Kenya's borders, the lake is a lifeline for thousands of nomads and their livestock. "According to our models, electricity production in Ethiopia will not restrict water availability in Kenya in the long term; at most, it will affect the temporal variability of the streamflow regime," says Burlando. "But the extraction of water for extensive irrigation poses a far greater threat." Energy production only requires the water to be stored and then channelled through turbines. This alters the natural course of the river by fragmenting it and modifying the natural flow regime, thus impacting aquatic ecosystems, but it has no effect on the total amount of water. A liaison at the institutional level is not yet on the agenda, and the conflict remains politically and technically unresolved. "But at least we got technical experts from Ethiopia and Kenya sitting at the same table and discussing concrete management scenarios and solutions for conflicting uses," concludes Burlando.

**BETTER COORDINATION** The EU follow-up project, GoNEXUS, hopes to apply the experience gained in DAFNE not just at the level of drainage basins but on a continental or even global scale. Between now and 2025, the international project team will work on eight case studies across Europe and Africa, with a focus on the dependencies between water, food, energy and ecosystems. At the same time, Burlando's research also has potentially clear benefits for Switzerland and its energy strategy. Under the auspices of the Swiss Competence Center for Energy Research, his team has developed a number of models that have been used to investigate exemplary hydropower storage systems such as the one on the Maggia River in the canton of Ticino, where four dams and multiple pumped-storage hydropower plants affect the natural floodplain of the Maggia. "In the case of the Maggia River, we were able to demonstrate that electricity production could be increased through a revision of the legally mandated release of excess water from individual reservoirs, which would also reduce the impact on the floodplan ecosystems," explains Burlando. He freely acknowledges that technical and scientific expertise alone are not enough to get an integrated water management strategy off the ground and that this can only succeed if the political will is there. Yet he still believes that political decisions could benefit from paying a little more attention to science. "We can definitely help politics to find compromises that are in the public interest," he insists. ○

**ROBERT BOES** is Professor of Hydraulic Engineering and Director of the Laboratory of Hydraulics, Hydrology and Glaciology (VAW) in the Department of Civil, Environmental and Geomatic Engineering at ETH Zurich.
—〉 vaw.ethz.ch

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—〉 hyd.ifu.ethz.ch

**SUSTAINABLE MANAGEMENT OF WATER RESOURCES** The Master of Advanced Studies in Sustainable Water Resources (MAS ETH SWR) is primarily aimed at students from the Global South with a Master's degree who wish to gain specialised knowledge of integrated water resource management for use in their country of origin. The Master's degree programme is offered by the Department of Civil, Environmental and Geomatic Engineering at ETH Zurich.
—〉 mas-swr.ethz.ch

# TRACES IN THE WATER

## How we are contaminating our waters with microplastics and a multitude of chemicals

TEXT Peter Rüegg

A plastic sandwich wrapper bobs in the water where the Limmat River flows out of Lake Zurich. The current carries it downstream through Zurich's historic centre before eventually depositing it on the bank of Werd island. Exposed to sunlight, it gradually breaks down into smaller and smaller pieces, which the rain then washes back into the river. Pebbles on the bed of the Limmat grind the fragments of plastic into even smaller pieces until they are all but invisible to the naked eye. What started out as a sandwich wrapper has now turned into microplastic.

Microplastics – tiny pieces of plastic that are smaller than 5 millimetres in size – are now ubiquitous. "You find microplastic particles everywhere, from mountain lakes and spring water to the most remote regions of the world's oceans," says Denise Mitrano, Assistant Professor of Environmental Chemistry of Anthropogenic Materials at ETH Zurich. She studies where microplastics come from, how they behave in the environment and whether they pose a risk to aquatic organisms.

Microplastic pollution stems not only from discarded plastic waste, but also from tyre abrasion, textiles and personal care products such as shower gels and toothpaste that use plastic microbeads as an exfoliating or scrubbing agent.

**THE ENTIRE NUTRIENT CYCLE** Researchers are currently investigating how harmful microplastics are to humans, animals and the broader ecosystem. One of the biggest challenges is establishing how much microplastic is present in the environment. To make this task easier, Mitrano and her colleagues have developed a new analytical method involving a polymer to which a metal has been added. This metal-enhanced plastic is ground into particles on the micro and even nano scale, some of which are far smaller than a micrometre in size. By analysing the metal contained in these particles, researchers can measure the quantity of microplastics in water, soil and tissue samples. This allows them to study the transport and fate of microplastic particles as they pass through organisms and accumulate there or in the environment.

In one of her experiments, Mitrano examined whether nanoplastics harm daphnia. Commonly known as water fleas, these tiny crustaceans filter plankton from the water for food. In doing so, they also ingest plastic particles. Her study confirmed that daphnia do indeed ingest nanoplastics but that they subsequently excrete them, seemingly unharmed. There appears to be no impact on their reproduction or growth. It is only after a few generations that impairments to their energy metabolism begin to show.

Mitrano's research has also shown how nanoplastics can cross the intestinal barrier in fish and end up in muscle tissue. "This didn't result in the fish dying, so it's likely that the particles are not acutely toxic," says Mitrano.

But that doesn't mean we can lower our guard, Mitrano adds. She explains how microplastics form clumps with planktonic algae in both freshwater and seawater, speeding up the algae's sedimentation rate. This is just one example of how microplastics can affect the entire nutrient cycle of a body of water – an indirect polluting effect that is often underestimated. "Microplastic research to date has primarily focused on direct effects. We need to expand our research to include evaluations of

negative impacts at the ecosystem level and to analyse the ecological implications," says Mitrano.

Microplastics also have other indirect effects, such as their tendency to release toxic substances. Manufacturers incorporate hundreds of additives into polymers to give them the desired properties. "We should therefore be asking what's really causing the harm: the polymers themselves, the shape and size of the microplastic particles, or the additives released by the polymers," she says.

**COUNTLESS CHEMICALS** Substances that leach from microplastics are far from being the only chemicals in the water. Over the past few decades, the chemical industry has created hundreds of thousands of compounds. In Europe alone, 26,000 new substances in quantities of at least one metric ton come onto the market each year. In most cases, their eventual fate remains unclear.

Kris McNeill, Professor of Environmental Chemistry at ETH Zurich, has long been interested in such questions. His research focuses on how synthetic organic molecules – particularly, active pharmaceutical ingredients – act as toxins in the environment and how they degrade. "From drugs and cosmetics to pesticides and fertilisers, everything we use in everyday life eventually ends up in rivers and oceans," he says.

Triclosan, an antimicrobial agent, is a good example. Originally used in hospital hand sanitisers in the US, it gradually found its way into numerous consumer products during the 1970s. By early 2000, 95 percent of all liquid hand soaps in the US contained triclosan. Only later did it become clear how unnecessary this ingredient actually was.

McNeill and his colleague William Arnold were able to demonstrate how sunlight breaks down triclosan in wastewater into dioxins, a group of highly toxic chemical compounds. "Sunlight can render many toxic substances harmless. But in this case, you end up with something much worse," says McNeill. Minnesota, where they conducted their research, became the first US state to prohibit the use of triclosan in consumer products. In 2016, the Food and Drug Administration (FDA) announced a ban on triclosan and other antimicrobial agents in certain products – a rare victory for the environmental chemist. "It's great to see that our results played such an important role in that decision," he says.

This case illustrates how environmental chemistry tends to lag behind the chemical industry. First, chemical companies invent new substances that rapidly enter into widespread use. Years later, environmental chemists such as McNeill discover that the chemicals are harmful to humans, animals and the environment. "It takes 30 to 40 years for the authorities to put regulations in place or announce a complete ban based on scientific studies," says McNeill. He argues that the process should be reversed, requiring the chemicals to be scientifically assessed before they are used. "This is the only way that we as a society can prevent a repetition of tragedies caused by chemicals like triclosan and all the other environmental toxins such as the industrial chemical PCB and the insecticide DDT," he says. ○

Image: Adobe Stock

Microplastics are formed by the disintegration or degradation of larger pieces of plastic.

**KRISTOPHER MCNEILL** is Professor of Environmental Chemistry at the Department of Environmental Systems Science.
⟶ envchem.ethz.ch

**DENISE MITRANO** is Assistant Professor of Environmental Chemistry of Anthropogenic Materials at the Department of Environmental Systems Science.
⟶ ecam.ethz.ch

# The great clean-up

From tackling micropollutants in wastewater to removing plastic waste from rivers, here are five solutions based on ETH expertise.

TEXT Karin Köchle ILLUSTRATION Benedikt Rugar


## ① Versatile filter system

ETH spin-off BluAct has developed a new kind of filter membrane. Made of whey proteins and activated carbon, it removes almost all contaminants from water – including lead, mercury, arsenic and even radioactive elements. The company's innovative filtration devices are suitable not only for industrial wastewater treatment, but also for purifying drinking water in people's homes. It can even be used to recover valuable metals such as platinum, gold and silver.

⟶ bluact.com

## ② Detect and destroy

Water resources contaminated with pesticides or pharmaceutical products pose a threat to ecosystems and human health. ETH spin-off Oxyle aims to these micropollutants at their source – in chemical plants, pharmaceutical companies and hospitals. The cleantech company has developed a catalyst-based technology that completely breaks down the micropollutants in the water instead of filtering them out.

⟶ oxyle.ch

## ③ Locally produced

Some two billion people around the world still lack access to clean drinking water. ETH start-up Openversum has developed an inexpensive water filter that can purify river water or water from polluted groundwater wells, making it safe to drink. Because the filter can be produced by small local manufacturers, it also helps create jobs. Following successful pilot projects, plans are now underway to introduce the system in Latin America and Africa.

⟶ openversum.com

## ④ Drinking water from the air

Researchers at ETH Zurich have developed the first zero-energy solution for harvesting drinking water from the atmosphere 24 hours a day. The technology relies on a condenser in the form of a self-cooling glass pane on which moisture from the air condenses. This innovative water-harvesting solution essentially allows the atmosphere to be used as a gigantic freshwater reservoir. Its use could help alleviate water shortages, especially in regions with sufficiently high humidity.

⟶ ethz.ch/condenser

## ⑤ Autonomous waste-collection vessel

How can we reduce the amount of plastic waste in our oceans? A group of ETH students decided to start with a technological solution for rivers. As part of their Autonomous River Cleanup project, they are currently developing an autonomous vessel that uses robotics and machine learning to collect waste. The students are working closely with a number of European universities and are supported by various partners in the private sector.

⟶ riverclean.ethz.ch

# RETHINKING WASTEWATER MANAGEMENT

Sewer systems and centralised treatment plants are not a sustainable solution for managing the world's wastewater. Environmental engineers at ETH Zurich and Eawag have been helping to develop decentralised, closed-loop modular systems.

TEXT Michael Keller

Out of sight, out of mind: we've been flushing away human waste ever since sewers were invented, using copious amounts of fresh water to expel it from our homes and cities as fast as the pipes can carry it. Modern urban water systems are widely regarded as one of the greatest achievements of the past century. They provide us with clean drinking water, channel our wastewater to treatment plants and divert rainwater away from built-up areas. "As a result, we enjoy dry and hygienic living conditions, two of the mainstays of public health in densely populated urban areas," says Max Maurer, Professor of Urban Water Systems at ETH Zurich and Eawag, the Swiss Federal Institute of Aquatic Science and Technology, which is part of the ETH Domain.

To achieve this, industrialised countries have built a vast amount of infrastructure – some 230 billion Swiss francs' worth in Switzerland alone. Laid end to end, Switzerland's 200,000-odd kilometres of water and sewerage pipes would encircle the globe five times. The extensive network of underground sewers carries wastewater to nearly 800 centralised treatment plants.

This approach to water infrastructure has proved its worth in industrialised countries – and for decades, it was also regarded as a benchmark for the rest of the world. "But the truth is that conventional urban water systems are no longer sustainable," says Maurer.

**FROM WASTE TO RESOURCE** Kai Udert, Professor at the Institute of Environmental Engineering at ETH Zurich and Senior Scientist at Eawag, is equally sceptical about conventional water infrastructure. "We use drinking water to dilute faeces, urine and slightly dirty water from bathrooms and kitchens and move them through the sewerage system – that's patently absurd!" he says.

Udert, an expert in process engineering, sees sewage not as foul-smelling waste that needs to be disposed of, but rather as a valuable resource that should be properly exploited. His explanation of

"Our conventional urban water systems are not sustainable."

Max Maurer

why we need to take a new approach is simple. "Wastewater is one of the last linear waste streams," he says. "We dispose of everything in the same way, regardless of whether it's clean or dirty. That's inefficient, and it creates all sorts of problems that people have been trying to fix for years." For example, conventional systems squander not only huge amounts of water and energy but also valuable nutrients which, if not fed back into the cycle, end up damaging the environment.

Meanwhile, the challenges are growing: the wastewater industry is struggling to deal with climate change, rapidly ageing infrastructure, a booming population and increasing urbanisation, as well as new pressure on treatment plants to remove micropollutants.

Maurer and Udert argue that it's time for a rethink. They are calling for a paradigm shift, moving away from a handful of centralised plants towards a decentralised system of wastewater treatment based on modular water infrastructure. This would give us a more efficient and effective means of managing urban water resources.

**RECYCLING AT SOURCE** "Think compact, highly efficient, decentralised systems that offer flexible wastewater treatment on a local level – that's the alternative we're proposing," says Maurer. At Eawag, Udert and Maurer have spent years developing suitable processes for small-scale treatment facilities. Their work is based on the three key principles that underpin a closed-loop sanitation system designed to conserve and recover resources. Separation at source – also known as No-Mix sanitation – seeks to segregate wastewater into its different fractions, because human waste and water are much easier to treat and recycle if they are not mixed together in the first place.

Resource recovery takes various forms: nutrients such as nitrogen and phosphorus can be obtained from urine and faeces, while greywater – slightly dirty wastewater from kitchens, bathrooms and washing machines – can be treated and reused multiple times. Thermal energy is also recovered. Similarly, applying recovered nutrients to the fields as fertiliser closes the nutrient cycle, thereby benefiting the environment and reducing dependence on imports of mineral phosphorus fertilisers.

The third principle, decentralisation, seeks to eliminate the costly transport of water through centrally managed pipe systems by ensuring that wastewater and waste can be treated as close to source as possible.

The researchers develop and test new wastewater technologies in the basement of NEST, the research and innovation building run by Eawag and Empa, the Swiss Federal Laboratories for Materials Science and Technology. Some of the processes they use stem from research projects launched over 15 years ago to develop off-grid sanitation solutions for countries in the Global South. Well-known examples include Vuna and Blue Diversion Autarky, which provide a safe and affordable way to dispose of wastewater without requiring a combined sewerage system and centralised treatment plants.

Image: Max Maurer/ETH Zurich


Beneath the Bahnhofstrasse in Zurich, a sewer conveys wastewater to the treatment plant. Rainwater is channelled through a separate pipe.

"Wastewater is one of the last linear waste streams."

Kai Udert

Vuna stands for "Valorisation of Urine Nutrients in Africa". In this approach, co-developed with ETH Zurich, separately collected urine is converted into fertiliser in a treatment plant located at a distance. The second project gave rise to the Blue Diversion Autarky toilet, a system that collects and treats urine and faeces and collects and recycles flush water in separate modules housed within a single structure.

**BIOGAS REACTOR AND PASTEURISER** Elizabeth Tilley understands all too well the importance of decentralised sanitation systems that do not require a water supply. Yet, in many regions of the world, fundamentally new concepts are required to make these work. Tilley began her research career at Eawag and completed her doctorate as part of the Vuna nutrient recycling project in South Africa, which was led by Udert. Today, she is Professor ⟶

> "Some 2.6 billion people have no access to safe sanitation."
>
> Elizabeth Tilley

of Global Health Engineering at ETH Zurich, where she and her research group work to devise affordable and socially acceptable solutions for the protection of human health and the environment.

Some 2.3 billion people around the world use on-site sanitation systems such as pit latrines. These serve as an initial barrier to excreta-related pathogens, but regular emptying of the latrine creates its own set of problems. If the sludge is simply dumped into the environment or left untreated, the risk of pathogens spreading – and the potential for outbreaks of diseases such as cholera – is high.

There is an urgent need for decentralised technologies that are robust, affordable and easy to operate. One promising technology is an anaerobic biogas reactor that is essentially a large, rubber balloon. This treats the faecal sludge to a certain degree, although not enough to make it safe for disposal. On the plus side, however, the process does yield a useful by-product in the form of a methane-rich gas (biogas), which can be used for cooking – just like propane or natural gas.

Together with Kenyan engineering firm Opero and a Mexican supplier of biogas reactors, Tilley and her team set out to discover if they could use biogas derived from the sludge to fuel a pasteuriser that would then heat the effluent to a temperature sufficiently high to kill all the pathogens. The project was funded by ETH for Development.

Julia Jäggi, a Master's degree student in the Department of Mechanical and Process Engineering, spent three months in the Kenyan city of Kisumu, on the shores of Lake Victoria, designing and testing a pasteuriser with the capacity to treat the waste of about 500 people a day. "Engineering in the lab is one thing, but this really put our flexibility and creativity to the test! Every day was about solving problems on the fly and making the most of the resources we had," says Jäggi. Tilley is confident that their system will soon be ready to deploy and will help prevent infectious diseases.

**TAPPING INTO EXISTING EXPERTISE** There's no doubt that water poses one of the biggest challenges of the future. Using this resource intelligently and sparingly is essential, both in Switzerland and abroad.

"The concepts we developed for poorer countries 15 years ago are becoming increasingly relevant to Switzerland. We're now reaping the rewards of this knowledge," says Udert.

Maurer and Udert believe we will soon be seeing modular treatment plants in urban areas and compact reactors to treat wastewater in homes. The COMIX research project, which was co-led by Maurer, recently examined the potential use of modular technologies in the Swiss water management sector. Its results suggest that the proportion of decentralised wastewater treatment plants could rise from 2.5 percent to 50 percent in the long term.

The researchers also see an opportunity for Switzerland to fast-track efforts to make its water infrastructure climate-friendly. This would give it the head start it needs to position itself as a lead market for the development and testing of modular water systems. Over the years, Switzerland has accumulated a wealth of expertise in all aspects of water resources management, thanks not least to its universities of applied science, industry and the institutions of the ETH Domain. "Yet this expertise has remained largely untapped," says Maurer.

It would take a concerted effort by research, industry and the public sector to conduct the pilot projects required to demonstrate the feasibility of this applied knowledge and to then create an initial market. "But when it comes to the processes, the know-how and the financial resources – it's all there already!" says Udert. ○

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⟶ ifu.ethz.ch

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# A WORLD IN FLUX

Heavier rain, longer droughts, melting glaciers: climate change has a dramatic impact on the global water cycle.

TEXT Felix Würsten

For Christoph Schär, ETH Zurich's Professor of Climate and Water Cycle, "global warming" is not quite accurate when it comes to describing the driver of climate change. "A better term would be 'climate humidification'," he explains. "Most of the solar energy that reaches the Earth serves to evaporate water and thereby drives the hydrological cycle." Properly accounting for the implications of this is the most challenging task of all for climate modellers. In order to build a global climate model, grid points spaced around 50 to 100 kilometres apart are used. This scale is too coarse to map small-scale, local thunderstorm cells. Yet it is precisely these thunderstorm cells – and where they occur – that drive atmospheric circulation, especially in the tropics, where solar radiation is highest.

The workaround, at present, is to add extra parameters to the model in order to map clouds. "But predicting future climate change is still pretty imprecise," Schär says. "If we don't know how many clouds are forming in the tropics, then we don't know how much sunlight is hitting the earth's surface – and hence we don't know the actual size of the global energy balance."

**AMAZING PRECISION** Over the next few years, scientists hope to address this imprecision. Schär, for example, is now working with models at a much higher resolution – 1 to 2 kilometres – which provide a much more accurate picture of meteorological activity. To illustrate this, he and his group run a sequence on a supercomputer that simulates weather events in the Tropical Atlantic over a period of years to decades. The visualisation is strikingly similar to a satellite image: rain fronts shift from east to west across Africa; finely structured cloud fields form off the coast of Brazil; hurricanes develop in the middle of the Atlantic and then head north. "The model doesn't know anything at all about the tropical climate," Schär enthuses. "But based on the laws of physics alone, it can still provide us with a realistic picture of what's going on!" It is still not feasible to create longer-term scenarios with such high-resolution models, but they do serve to make current global models more accurate.

Using the example of southwestern Europe, Schär shows how high-resolution models are also able to predict extreme weather events much more accurately. Current models massively underestimate the amount of rain that can fall in an hour. By contrast, high-resolution models generate highly realistic distributions and correctly identify that in autumn, for example, there is a strong likelihood of especially heavy rainfall and flooding on the southern edge of the Alps, along the Ligurian coast and in Provence. ⟶

Today's projections of extreme precipitation events are consistent with a physical law formulated in the 19th century by Rudolf Clausius and Émile Clapeyron. "They were just doing basic research," Schär explains. "Practical applications in climate change weren't even on their radar back then." The Clausius-Clapeyron relation says that the atmosphere can hold around six percent more water vapour per degree Celsius of warming. In other words, we can expect to see substantially heavier precipitation events in future. "That will have consequences for flood prevention," says Schär. "We'll no longer be able to design flood protection on the basis of past events."

The laws of physics tell us that a warmer atmosphere will absorb more water vapour. Despite this, many regions are expected to suffer from water shortages. Schär explains the apparent paradox: "The absolute moisture content of the atmosphere is rising overall, but relative humidity can also fall regionally. In other words, more water will evaporate from the ground; but at the same time, cloud formation will also decline in certain regions, where there will then be less precipitation." This will have serious consequences not only for southern Europe, says Schär, but also for North African countries, which are already struggling with water shortages.

Image: Juergen Freund/Nature Picture Library/Science Photo Library

For more accurate forecasting, climate models also need to accurately map small, local thunderstorm cells.

**FLOODS AND FOREST FIRES** Too much water, or too little, is likewise a key concern for hydrologist Manuela Brunner. An assistant professor at ETH, she focuses on the impact of extreme climate events on mountain regions. "Mountain water plays a central role in the development of both flooding and drought," she explains. "And mountains are especially impacted by climate change because temperatures there rise more than they do in lowland regions."

To investigate whether flooding is likely to become more frequent and more intense in the future, Brunner uses a combination of observational data and model-based simulations. "In the Alps, it's very much a mixed picture for the kind of moderate flooding that typically occurs once every 10 to 20 years," she explains. "In some areas, this risk has increased; in others, it's actually declining." One key factor here is the state of the soil: "If the soil is dry, it can absorb a lot of water and thereby mitigate flooding. But if the ground is already saturated, this effect is lost."

However, Brunner expects an increasing risk of extreme, 100-year flood events across the entire Alpine region. "In that case, there's so much rainfall that the condition of the ground doesn't make much difference," she says. And while we know the individual factors that can cause flooding, she explains, we still lack the understanding of how they interact. "What happens, for example, when there's heavy rainfall during snowmelt?" she asks. "When does this develop into an extreme event? And how often will we see this combination?"

Flooding is not the only threat facing the Alpine region. "In future, we're going to see more frequent periods of drought on the northern flank of the Alps and possibly even forest fires," Brunner says. A number of factors come into play here: firstly, rainfall in summer is decreasing; secondly, soil evaporation is increasing because of higher temperatures; and thirdly, snow levels in spring are declining, which in turn means that vegetation is more prone to drying out. "Although precipitation in the winter months is generally increasing, higher temperatures mean that less and less of this is stored in the form of snow," Brunner explains. "And if there's less snow cover in spring, as we enter the warmer months, this can aggravate water shortages during dry summers."

Brunner is particularly alarmed by the prospect of drought periods lasting several years. "In the past, we didn't have to worry after a dry summer in the Alps, because there was always enough precipitation by the end of the following winter to compensate," she says. "But in future, water shortages may in fact worsen over the winter."

**HOW FAST ARE GLACIERS MELTING?** To make matters worse, it is now clear that glaciers will soon cease to deliver the same amount of meltwater in summer as they have done in the past. "In a best-case scenario, Switzerland will still have 40 percent of its current glacier volume by the year 2100," says Daniel Farinotti, Professor of Glaciology at ETH Zurich. "In the worst case, only a few percent will be left." Whatever the case, he is confident in Switzerland's ability to track these changes: "We know exactly how much ice is still there because we've already done radar surveys on most of the glaciers ."

Things are more complicated in the Himalayas, where Farinotti and his team are also running a project. There, the glaciers lie at a much greater altitude, which makes a survey more difficult. At the same time, surrounding countries are reluctant to provide data for research because of strategic and geopolitical reasons. Forecasts of when glacier melt will peak in the Himalayas can therefore vary by as much as a decade. "For the lowlands, which are much more densely populated, that makes a huge difference," he says.

In Switzerland, too, there is an urgent need to know how much water will be contributed by glacier melt in future – not least because the concessions for a number of hydropower plants are up for renewal in the next few years. Such operators not only need to know how much water will be available to them in the future; they also require detailed forecasts regarding extreme weather events. "They're anxious about whether water intakes have sufficient capacity," Farinotti explains.

Another issue is of even graver concern: the melting of the polar ice sheets. "In our group, we're currently building a detailed flow model of the Greenland Ice Sheet based entirely on physical processes," Farinotti explains. "We're mapping the ice masses to a resolution of 25 metres in order to assess what will happen to the ice sheet over the next few decades." To run this complex simulation, the team is set to make use of LUMI, Europe's fastest supercomputer.

Alongside other researchers, Farinotti's group is also investigating the Antarctic Ice Sheet, which faces a number of threats. In particular, there are issues with the Western Antarctic Ice Sheet, which rests on bedrock beneath the surface of the ocean. "The topography of this bedrock plays a key role in how quickly the ice will retreat," he explains. This is, without doubt, a vital question for a number of coastal regions around the world. "If the West Antarctic Ice Sheet starts melting, sea levels could rise by as much as 1 metre by the end of the 21st century," Farinotti says. With 250 million people living in areas that would then be underwater, there's no need to ask why the future of the polar ice sheets is also of such importance at lower latitudes. ○

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Financial expert Stefan Spiegel, 52, is the new Vice President for Finance and Controlling at ETH Zurich.

Image: ETH Zurich/Markus Bertschi

# New Vice President for Finance and Controlling

Stefan Spiegel took up the post of Vice President for Finance and Controlling at ETH Zurich on 1 April 2023. The 52-year-old Swiss national is a proven financial expert who brings many years of experience as an executive in both the corporate and public sectors. He is therefore familiar with the procedures and particularities of organisations funded via public financing mechanisms and has experience dealing with public authorities and agencies. Spiegel takes over from Robert Perich, who opted to step down from the ETH Executive Board as of 31 March 2023 (see page 36).

Spiegel is a team player known for his patience and tenacity, especially when it comes to digital transformation and organisational development. His achievements include the introduction of AI support into planning, reporting and decision-making processes. "I would describe myself as a bold and creative decision-maker, and someone who attaches great importance to meaningful visions, realistic goals and transparent communication with all stakeholders," he says.

**FROM PHYSICS TO FINANCE** Spiegel originally studied theoretical physics at the University of Zurich. He graduated in 1997 and went on to gain his first professional experience at Baloise Insurance. From 2001 to 2007, he worked at the post office network division of Swiss Post, where he ended up serving as Head of Controlling and also as Interim Finance Director.

After two years as VP Group Controlling at the listed trading company Valora, Spiegel moved to Swiss railway operator SBB in 2009, where he oversaw the reorganisation of corporate controlling until 2011. He was also project manager for the reorganisation of the company's entire

finance department, which counted over 700 employees. From 2011, he was CFO and a member of the executive board at SBB Cargo Group.

**DIGITALISATION WITH AI** During his tenure as finance director at SBB Cargo, Spiegel led the firm's financial turnaround, introduced a new SAP-based accounting system and initiated the digital transformation of SBB Cargo and its finance department, which has since benefited from the introduction of artificial intelligence and machine-learning methods.

In addition to completing a number of advanced training courses in finance, organisational development, leadership skills, data analysis and machine learning, Spiegel also holds an Executive MBA from the Vienna University of Economics and Business and the University of Minnesota's Carlson School of Management.

At ETH Zurich, he now heads up the Executive Board domain for Finance and Controlling and is partially responsible for digitalising the university's administrative processes. Spiegel's remit includes financial strategy and planning, the budgeting process, financial management, controlling and risk management.

"I'm excited and inspired by this new challenge at ETH Zurich," says Spiegel. "And I'm looking forward very much to using lean, targeted processes and innovative modern methods to further develop the excellence and user-friendliness of financial services and financial controlling for all stakeholder groups at ETH. In this way, I hope to contribute to the national and international standing of this top global university and to help create a motivating working environment."

ETH President Joël Mesot is delighted to have Stefan Spiegel on board: "He's an experienced leader who is highly familiar both with the corporate world and with the particularities of a federal institution." ○

# PHILANTHROPY

BY
Donald Tillman

## Here's to the next 20 years!

This summer, ETH Zurich will be celebrating the 20th anniversary of the ETH Foundation. To give our valued donors and other interested parties an insight into how philanthropy and partnership have benefited ETH over the past two decades, we recently shared some key milestones on our website. With the help of donors, we have, for example, funded 643 Excellence Scholars, fuelled research in important fields such as cryo-electron microscopy, and accelerated major projects such as the development of an artificial heart. During my time as managing director of the ETH Foundation, I had the privilege of seeing first-hand the exciting progress made by numerous individuals. These included Excellence Scholars such as Marco Hutter, a young entrepreneur who received a scholarship in 2014 and went on to found the robotics spin-off ANYbotics. Today, he is an ETH professor and one of the world's leading figures in the field of robotics. This is just one of the many success stories made possible by over 7,000 donors. So, here's to the next 20 years – and also to my future role as a donor!

—〉 ethz-foundation.ch/en/impact/

# Exemplary leadership

Image: provided

Thomas Meierhans is the winner of the 2023 Art of Leadership Award (ALEA). As the manager of the metal workshop in the Department of Civil, Environmental and Geomatic Engineering, he is in charge of a group of around seven technicians. This ETH prize is awarded to leaders who help create innovative, modern working conditions and who actively encourage and support staff in achieving a healthy work-life balance and participating in activities outside the office. ○

Video of Thomas Meierhans and his team:
—〉 youtu.be/d_kuGlTtnx0

# Keeping pace with the best of them

For years, ETH Zurich has ranked among the top ten universities in the world, according to the annual QS World University Rankings. This year, Quacquarelli Symonds (QS) has published its rankings according to subject – and here, too, ETH has risen to the top! The university appears in the top ten in a total of 16 subject areas, with three disciplines from the field of earth sciences taking the highest spots. "ETH consistently achieves outstanding rankings across all disciplines. We have every right to be proud of these achievements, which ultimately benefit the whole of Switzerland. So it's definitely something worth celebrating!" says Joël Mesot, President of ETH Zurich. "I urge our politicians to put the necessary conditions in place to ensure we continue to keep pace with the best in the world." ○

# Redoubled support

Plans are already in place to build the Centre for Students and Entrepreneurs on the Hönggerberg campus. Envisioned as a meeting point for science and industry, this new innovation centre will provide talented young people with the opportunity to gain experience outside the curriculum, expand their network and advance promising new technology. Funding of the project is already well underway thanks to partnerships with UBS, BKW and the SWF Stiftung für wissenschaftliche Forschung, as well as donations from private individuals. Fondation Alcea has also pledged a generous sum towards the project and, to provide an extra boost, has also accepted a challenge to double any donations made by alumni and alumnae, ETH employees and students as well as companies spun off from ETH. ○

Find out more about the project, make a donation or check the progress of the fund-matching challenge:
—〉 hic.ethz-foundation.ch/challenge

Image: Buchner Bründler Architekten/Filippo Bolognese Images

The new centre for creativity, innovation and entrepreneurship will be built on the Hönggerberg campus.

Emilio Dal Re, Anetta Platek-Mielczarek and David Taylor, co-founders and managing directors of Unbound Potential, in the makerspace of the Student Project House.

# Innovative flow batteries

TEXT Karin Köchle

It's been quite a success story for start-up Unbound Potential – and it all began with a project in the Student Project House at ETH Zurich. The goal was to find an innovative solution for long-duration energy storage. David Taylor, who was working as a postdoc at ETH at the time, teamed up with colleagues from various disciplines to develop a novel concept for a redox flow battery and build initial prototypes. By opting for immiscible electrolytes, they eliminated the need for an ion-exchange membrane, paving the way for a battery that offers a more efficient, affordable and sustainable way to store renewable energy for long periods of time.

It took the team just under two years from the initial idea to the launch of their start-up Unbound Potential in January 2023. Funding came from Germany's Federal Agency for Disruptive Innovation (SPRIN-D), which awarded the founders a project grant of 1 million euros as part of its Long-Duration Energy Storage Challenge. ○

**STUDENT PROJECT HOUSE** At this creative thinkspace and makerspace, ETH students from any discipline can receive support in developing and implementing their own project ideas. In this way, they learn about the various stages of the innovation process.
⟶ sph.ethz.ch

Video:
Unbound Potential
⟶ youtu.be/8z_hmzF41ao

Image: ETH Zurich / Nicole Davidson

# "Finance is a means of accomplishing things, not an end in itself"

For 20 years, Robert Perich helped shape the development of ETH Zurich in his role as Chief Financial Officer (CFO). His departure at the end of March marked the end of an era.

TEXT Florian Meyer

Robert Perich is starting a new chapter in his career at ETH Zurich. For 20 years, he helped shape the university's finance system in his characteristic frank and no-nonsense style, working with his team to transform it into a modern instrument of university management. Now his term as Vice President for Finance and Controlling has come to an end. His next step will be to spend some time in Cambridge. After that, he will take over as Academic Director of the Swiss School of Public Governance and begin his new role as Professor of Practice at the Department of Management, Technology and Economics. "I'm looking forward to taking things a little easier now," says Perich. "But I'm also excited by the opportunity to tackle new challenges in this final stage of my career and to pass on the knowledge and experience I gained from all my years working in university management."

Over the two decades in which Perich was responsible for finance and controlling at ETH, first as Director and then as Vice President, the task of managing the university became steadily more complex. At the same time, the various stakeholder groups were ramping up their demands in regard to the planning and allocation of funding and the transparency of how these funds were used. ETH itself experienced significant growth during this period. Since 2003, for example, the number of students has doubled, while the number of employees has increased by 80 percent and the number of professorships by 70 percent. At 1.85 billion Swiss francs, ETH's annual budget is also a good 70 percent higher than it was in 2003, though this also reflects a greater share of project-oriented third-party funding and donor funds due to targeted diversification.

**FACT-BASED DECISION-MAKING** "Money and finance are not an end in themselves, but rather a means to accomplishing desired outcomes," says Perich. "For me, financial planning was always more than just a technical task. I wanted to give ETH greater freedom and flexibility in its teaching, research and knowledge transfer by providing stable financial planning and transparency." A key element of Perich's approach to finance and controlling is to underpin strategies and goals with facts and thus to present the benefits and value of science in concrete terms.

In fact, Perich's time at the helm saw a fundamental shift in how ETH manages its financial affairs. One obvious example is the annual financial statement in ETH's annual report, which has been issued in full compliance with International Public Sector Accounting Standards (IPSAS) since 2017. "I'm

delighted to say that ETH Zurich is currently one of the few universities in the world to be certified as fully IPSAS compliant," says Perich. "The quality of our financial management systems and the transparency of how our funds are used are well on par with the standards of private-sector organisations."

**CLEAR GOVERNANCE** Perich achieved some important milestones early on. However modest they may appear, the ETH financial regulations introduced in 2005 and the ETH information and support system introduced in 2008 in conjunction with the ETHIS portal were actually of great significance. These measures provided the essential foundations for ETH to manage basic, day-to-day administrative processes in finance, human resources and procurement efficiently and, increasingly, digitally.

Both the financial regulations and ETHIS take into account the peculiarities of how ETH operates as a university, including the fact that the ETH Executive Board, academic departments and professorships share responsibility for university management (shared governance) while delegating as much responsibility as possible to the individual academic units in a manner appropriate to their level (subsidiarity principle). When Perich compares ETH to the corporate world, he regards it not as a company that can be run strictly from the top down, but rather as a kind of holding company consisting of a diverse network of 560 professorships, each of which acts largely independently, much like SMEs. This generous degree of autonomy and its responsible use "on the ground" are key factors for success in the dynamic global competition for scientific excellence.

Perich started attending Executive Board meetings while he was still Director of Finance and Controlling, though without voting rights. He subsequently joined the ETH Executive Board in 2008, marking the first time a member had been drawn from somewhere other than the ranks of the professors. "I was accepted right from the start," says Perich. "They particularly appreciated my ability to bring a professional management perspective to the table and combine it with the requisite understanding of the needs of the academic environment. I have no doubt that I helped provide that extra dose of diversity that the Board needed."

**LEAN YEARS AHEAD?** All in all, Perich took part in some 550 Executive Board meetings and worked with a total of 18 Executive Board members (including six presidents). What impressed him most about these meetings was the members' ability to discuss controversial issues with courtesy and respect while remaining firmly focused on the facts: "Instead of prioritising our own department's agenda, we were always seeking the best outcome for the organisation as a whole."

Image: ETH Zurich/Daniel Winkler

After 20 years as Chief Financial Officer of ETH, Robert Perich is now moving into academia and passing on his wealth of experience in governance and public management.

Perich left ETH on a sound financial footing when he handed over the university's financial affairs to his successor, Stefan Spiegel. But how does he rate its prospects for the future? With the Swiss government already having announced cost-cutting measures in education, research and innovation, might ETH soon have to tighten its belt? Perich's response is that government budgets are always subject to cyclical economic and structural factors; in fact, he still recalls the period of cost-cutting pressures that accompanied his first year at ETH in 2003.

Nonetheless, he is conscious that the stable growth prospects to which we had become accustomed have been clouded since 2020 by a combination of the coronavirus pandemic, the war in Ukraine, supply bottlenecks, rapid increases in inflation and rising prices for energy and raw materials. "It's going to take some time for the situation to improve, so everyone at ETH will need to keep costs down for the time being," says Perich. "But I feel confident that ETH will come out of this even stronger." ○

# Digital and interactive

The ETH Zurich *Annual Report 2022* is now available online. Published this year for the first time in digital form, it offers an insight into all areas of ETH. This year's report also features an interactive value creation model designed to illustrate how the university works and the contributions it makes to society. In his foreword to the report, ETH President Joël Mesot underlines that all the research, teaching, continuing education and knowledge transfer conducted at ETH are pursued not as ends in themselves but rather for the benefit of society. "We firmly believe that research and science are drivers for positive change," he writes. ○

Read the new digital *Annual Report 2022* of ETH Zurich:
⟶ ethz.ch/annualreport

# Major commitment to innovation and talent

The latest Annual Report from the ETH Foundation highlights some of the projects that were made possible at ETH Zurich last year by the generosity of donors and partners. Besides furthering research into the origins of life, their funding also helped support outstanding students as well as decisively advance the creation of a joint forum for ETH students and members of the business community. Last year, ETH Zurich enjoyed the support of over 2,900 individuals, foundations and companies. In total, it received more than 3,600 donations, bequests and legacies to a value of 111 million Swiss francs. ○

Read the full annual report:
⟶ report22.ethz-foundation.ch/en

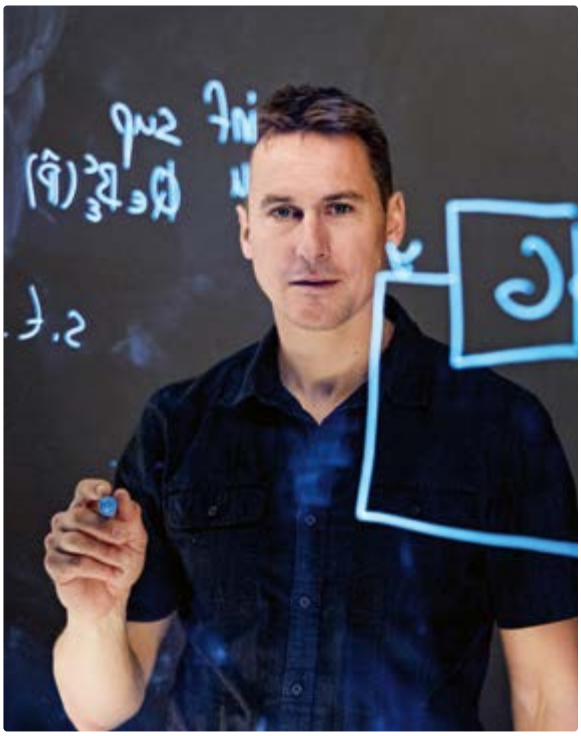
# Spark Award for new corrosion protection

The ETH Zurich Spark Award 2023 has gone to a new system of corrosion protection that is reusable, auto-repairing and more effective than conventional methods. At the award ceremony, which was attended by some 200 guests, Walter Caseri, Professor of Multifunctional Materials, Marco D'Elia and Mirko Magni accepted the Spark Award on behalf of all five members of the research team. "This new technology marks a major improvement in corrosion protection and will help promote the circular economy," said Vanessa Wood, ETH Vice President for Knowledge Transfer and Corporate Relations. Not only is the material reusable, she added, but it can also repair damaged areas – two features that mean big market potential. ○


Image: ETH Zurich/Oliver Bartenschlager

Winners of the Spark Award 2023 (right to left): Walter Caseri, Marco F. D'Elia and Mirko Magni, with Vanessa Wood, ETH Vice President for Knowledge Transfer and Corporate Relations.

# IN PERSON



For Florian Dörfler, control engineering is the cornerstone of all automation. When away from work, however, he prefers to experience nature without feedback loops.

**FLORIAN DÖRFLER** is Associate Professor of Complex Systems Control at the Department of Information Technology and Electrical Engineering.
⟶ control.ee.ethz.ch

**Your field of expertise is control engineering. Where might we encounter this in everyday life?**

Control engineering is based on feedback between the physical world and the world of algorithms. Whether we realise it or not, automation via feedback loops is part of our daily lives. It's behind cruise-control systems in cars, for example, the tech in our household appliances, and the systems used to cushion vibrations in bridges.

**Does control engineering play a role in fake news?**

There are feedback loops in social systems as well. By building mathematical models based on huge amounts of data, we can validate some of the classic hypotheses in sociology – to show, for example, how fake news spreads across social media channels.

**ETH now offers a joint degree programme with Ashesi University. What inspired you to teach in Africa?**

I wanted to experience a new culture and help educate people in Ghana. And I was also interested to learn from students and colleagues there. Students in Ghana arrive with less prior knowledge, but they are extremely motivated and hungry to learn. I ended up setting the same exam there as I would at ETH. And guess who got the best results!

**Does your work creep into your private life – for example, with thoughts of smart homes and autonomous vehicles?**

I spend enough time thinking about futuristic technologies when I'm at work! What I want when I'm not working is a bit of variety. I often feel a need to get away from our hectic, connected, technologised world! What I like most of all is to head way up into the mountains, just with friends, or to spend time in the countryside with my family.

**Which development will have the greatest impact over the next few years?**

Automation was originally a very analogue field, but today's problems demand a digital and algorithmic approach. Real-time optimisation and machine learning are becoming more and more important across every field of application. At the same time, new developments such as quantum technology will also require new approaches in automation technology. Exciting times! ○

INTERVIEW Karin Köchle

Image: Stefan Weiss

# TAKE A DEEP

# BREATH

TEXT Corinne Johannssen
IMAGES Daniel Winkler

Materials scientist Maria Novaes Silva studies pulmonary surfactant in the lab.

REPORT | Pulmonary surfactant is a special fluid released by cells in the lungs. For premature babies and COVID-19 patients in intensive care, it can mean the difference between life and death. An ETH materials scientist hopes to shed some light on this complex substance.

It's not easy to keep up with Maria Novaes Silva as she strides briskly down the corridors of Jan Vermant's lab at ETH. One minute she's upstairs – the next, she's down in the windowless basement, pulling on a lab coat and preparing for her next experiment. Carefully pouring an opaque liquid into a small Perspex chamber, she immediately becomes calm and focused. "This complex fluid was obtained from the lungs of animals – it's called pulmonary surfactant," she says. In the course of her doctoral project, Silva hopes to gain a better understanding of this remarkable substance.

Surfactant is produced by specialised cells in the lungs. It makes breathing easier and prevents the lung's tiny air sacs, known as alveoli, from collapsing after exhalation. Surfactant also has important medical applications. If a premature baby is born before its lungs are fully developed, it has a much lower chance of survival. One way doctors can help is by injecting surfactant into the lungs to keep them working properly. In COVID-19 patients needing a ventilator, the alveolar cells that secrete the surfactant are impaired.

Jan Vermant, ETH Professor of Soft Materials and member of the Competence Center for Materials and Processes (MaP), has frequent contact with doctors and other medical professionals. One thing he has learned from them is that mechanically ventilated patients must be induced to take a deep breath from time to time because a constant rate of ventilation causes their lung function to ⟶

1

1
Silva is a doctoral student in Jan Vermant's lab.

2
Silva uses a small Perspex chamber to simulate breathing.

2

deteriorate. Medical experts are still exploring exactly why it is so important for the lungs to be fully inflated on a regular basis – but young parents may be comforted by the notion that their crying infant is giving its lungs a good workout!

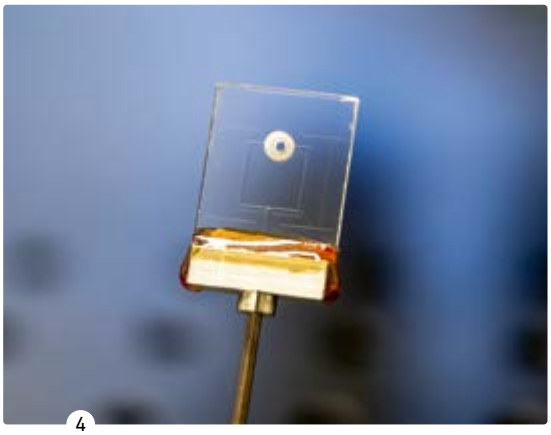
"Taking a deep sigh from time to time is important for our breathing," says Silva. She suspects that this is somehow related to the surface tension of the surfactant. Intermolecular forces act to minimise the surface area of a liquid, and this surface tension is also the reason why water droplets are spherical.

To test her hypothesis, Silva simulates an average breathing rate with the Perspex chamber. As she does so, she also measures the surface tension of the surfactant. In an initial experiment, the air flows evenly in and out of the chamber to simulate a resting breathing rate. The surface tension in this case is 25 millinewtons per metre. "That's pretty high, at least in a breathing context," Silva explains. "If our lungs were always battling that level of surface tension, breathing would be exhausting!"

In a second experiment, she interrupts this steady resting breathing rate with a single, larger intake of air after approximately every fourth cycle of inspiration and expiration. When regular breathing resumes, the surface tension has fallen from 25 to 15. "We think that occasional deep breaths might be an important factor in reducing surface tension and making it easier to breathe," Silva says.

To illustrate her point, Silva has prepared a presentation in the seminar room. She explains that our airways ramify more than 20 times, continuously dividing into smaller and smaller branches – from the trachea, bronchi and bronchioles all the way down to the alveoli. At the end of this respiratory tree, the alveoli form a network of several hundred million vesicles, connected by alveolar pores. These tiny air sacs inflate during inhalation and deflate during exhalation – and they are lined with surfactant to prevent them from collapsing after exhalation.

**DEEPER AND DEEPER** Back in the lab, Silva fills a different piece of equipment with animal surfactant. It resembles a giant spider with spindly



3
Silva uses a microscope to see what's happening inside the ring.

4
The small ring is designed to mimic the alveoli.

silver legs. Suspended from its body hangs a thin needle, seemingly hovering over the surfactant. There is only a handful of these systems worldwide, all of which were developed in the ETH lab. Down in the basement, Silva's goal was to simulate natural breathing: a few gentle breaths interspersed by the occasional deep one. Here, in the upstairs lab, the simulation is designed to mimic several softer resting breaths that gradually get deeper and deeper until they become a deep sigh. These expansions and contractions cause alterations in the surface area of the surfactant. The needle measures the surface tension throughout the experiment, allowing Silva to determine what happens as breathing becomes deeper. Currently, her results suggest that this expansion of the lungs is what reduces surface tension and makes breathing easier.

"Obviously, the situation in the lungs is much more complex!" she says, almost apologetically. "But as materials scientists, our task is to characterise the individual properties of a material as precisely as possible, so we deliberately attempt to untangle the complex interplay between the various forces."

Silva still has one more piece of test equipment to put through its paces. Under the microscope is a small ring with a hole in the middle. It is surrounded by tiny pores and filled with surfactant. Using a special device, Silva applies ⟶

5
Silva fills the unique apparatus with surfactant.

pressure to the liquid. As she does so, the film gets thinner and eventually breaks. “Don’t worry, that’s meant to happen!” she says, smiling. During her presentation in the seminar room, she mentioned that alveoli are connected by pores. One possibility, she says, is that the thin film of surfactant breaks during breathing. This then equalises the pressure within the alveoli via the tiny pores between the vesicles.

**INJECT – OR INHALE?** Silva is clearly fascinated by this mysterious fluid. But her experiments with surfactant are also motivated by the search for medical applications. These include the administration of surfactant to premature infants. Although this is often delivered as an injection, there are also non-invasive approaches that involve administering the surfactant as an aerosol via a breathing mask. “We hope our research will identify parameters that can improve this method,” says Silva. “By understanding the mechanisms at work here, we can help medical experts create even better tools.”

Silva knows what she’s aiming for – and she clearly has the perseverance, motivation and energy to achieve it. ○

**DOCTORAL SCHOOL** The MaP Doctoral School was established in 2021 to help foster a sense of community among students from multiple disciplines. It provides leading-edge education in five thematic tracks that reflect the main areas of materials and process research at ETH Zurich. Each track includes customised activities, such as advanced seminar series, lab tours and excursions. The programme also emphasises the development of personal and transferable skills. Run by the ETH Zurich Competence Center for Materials and Processes (MaP), the Doctoral School brings together 80 research groups from 11 departments with over 600 doctoral students.
—〉 doctoral-school.ethz.ch

# NEW POWER FOR THE ENERGY MARKET

TEXT Santina Russo
IMAGES Daniel Winkler

During her doctoral studies, Liliane Ableitner developed a trading and billing tool for energy communities. Three years on, she is CEO of a flourishing start-up with 20 employees.

Liliane Ableitner is the epitome of a successful businesswoman. In a very short space of time, she has accomplished an effortless transition from doctoral student at ETH Zurich to CEO of a start-up with an international customer base. She holds TED talks and has been interviewed a number of times by Handelszeitung newspaper. She also featured on the 2020 Forbes list of the most influential 30 people under the age of 30 in Germany, Austria and Switzerland. More importantly, she deals on a daily basis with the CEOs of major energy companies, discusses future developments in the power market and explains how her company, Exnaton, and its software can help shape these trends. Despite her relatively young years, 32-year-old Ableitner oozes confidence and experience – something she worked hard to acquire. "It's a fairly traditional industry, and there are times when I have to be assertive," she laughs. Like Ableitner herself, the company's software has injected new power into the energy market.

**A SCEPTICAL MARKET** Ableitner first developed an interest in energy as a business informatics student at the University of Bamberg in Bavaria. "What bothered me most was how to make private households a part of the energy transition," she says. During her doctorate at ETH, she first worked on ways of visualising household energy data. "Direct feedback shows people exactly how much power and hot water they use," she explains. "And it tells them that if they make savings here, they'll be doing their bit for the environment." She then decided to incorporate data on the power generated by households with solar panels. Her idea was to hook up all these households and thereby enable local power trading. Together with fellow students from ETH, she submitted a research proposal to the Swiss Federal Office of Energy. Funding was granted, and the project quickly grew to include researchers from the University of St. Gallen and commercial partners such as Swiss utility company BKW and Swiss federal railway SBB.

Yet there was pushback in the early days. "A lot of the established power generators were at the kick-off meeting, and all of them were sceptical," Ableitner recalls. A key argument was that people weren't interested in local power trading and that it was too early for such a project. "We were all a bit down after the meeting," she says.

**LOCAL POWER TRADING** Determined to press on regardless, the team developed a prototype of the software together with a smartphone app. One of Ableitner's jobs was to design, programme and evaluate the app. Field testing was then carried out in partnership with the relatively small utility EW Walenstadt, which made the app available to 40 households in Walenstadt, a municipality in the canton of St. Gallen. Some generated their own solar power, others purchased the surplus, and the app – now named "PowerQuartier" – ensured smooth trading. By analysing thousands of data points from smart meters in homes, it was able to show real-time power consumption and who was trading with whom. It also provided a platform where households could bid to buy or sell power, thereby enabling an algorithm to calculate supply and demand.

When Ableitner and her colleagues looked at the usage data from the Walenstadt energy community, they were amazed at the take-up. Most households were logging on to the app at least once a month, some of them even daily. "They were far more conscious of their electricity consumption than households normally are – most people only check once a year, when their bill arrives!" says

**LILIANE ABLEITNER** studied business informatics at the University of Bamberg, Germany. For her doctoral project at ETH Zurich, she co-developed software and a smartphone app that visualises energy data and enables energy communities to trade solar power produced by member households. In 2020, she joined forces with two partners from this project to launch the start-up Exnaton.

Ableitner. Power trading worked well, too, with households eagerly adjusting their bids and thereby helping to set prices on their own market. And then, all of a sudden, the pioneering project was hitting the headlines right across Switzerland. People kept calling the team at ETH to ask if they could join up. "They all wanted to know when it was coming to their hometown," says Ableitner, smiling at the memory. Spurred on by the unexpected success of the project, Ableitner quickly moved to set up Exnaton in 2020, together with co-founders Anselma Wörner and Arne Meeuw.

**COMBINING OLD AND NEW** One of the immediate difficulties the start-up encountered was knowing how to tell good advice from bad. "You get feedback all the time – from the colour of your logo to the structure of your business model," Ableitner says. On the hunt for capital, the new company team held countless pitches for investors. All of them had suggestions. "Some said we should sell PowerQuartier to utilities, others advised against it, saying we should target households directly," she explains.

In the end, Exnaton opted to work directly with the utilities. Tailoring their business to the growing number of households that produce their own electricity is a crucial step for these companies. They need to offer the kind of services that will enable them to keep hold of their customers during the energy transition – and that's exactly what PowerQuartier does. Electricity data from local energy communities involves a complex mix of different tariffs at different times – something that can only be handled by a tool that operates at a suitably granular level. "We help utilities to combine the old with the new," Ableitner explains. "With PowerQuartier, they can use their grid infrastructure to provide energy communities with the information and services they need."

**VIRTUAL WORKSPACE** Exnaton is still very much a David among utility Goliaths. So how does the company hold its own? "It really helps to have confidence in your own vision, because then you know what you're fighting for," says Ableitner. This is what much of her job entails. As CEO, she is the public face of the company, responsible for sales and marketing, and in charge of a team of 20. Some of the company's employees work in the main office in Zurich, while others are based in Germany, Sweden, Belgium, Italy, Spain and Egypt. They meet up in a virtual workspace created by a tool called WorkAdventure. Here, employees assume avatars reminiscent of first-generation Nintendo characters and can confer one-on-one or join a virtual meeting room that automatically launches a video conference. "This helps forge a strong team bond despite the distance," the CEO explains.

At present, most of the company's customers are in Germany, Austria and Luxembourg. In Switzerland, by contrast, the idea of creating energy communities across whole neighbourhoods is still being discussed in parliament. Other countries are further ahead. In Austria, for example, utilities are now using PowerQuartier to offer energy communities a subscriber service costing between three and four euros a month. "In return, the utility takes care of the practical side of power trading," explains Ableitner. Households, meanwhile, are provided with the power trading app and can do their bit for the environment – precisely what she wanted to achieve from the very start.

So what's her next goal? "Obviously, I'm going to be concentrating on the company for the next few years," she laughs. After that, she could easily imagine setting up a new company – and if she can find another opening in the market, it might well end up being another energy start-up. ○

"We help utilities to combine the old with the new."

Liliane Ableitner

○ Tours

## Plant-based meat

Planted, a successful ETH start-up, has been producing plant-based meat substitutes since 2019. Its vegan chicken, for example, contains nothing more than peas, water and rapeseed oil. Visitors to the company's futuristic steel-and-glass factory in Kemptthal can find out which plant proteins are used in the production of plant-based meat and where they come from. Bon appétit!

8 August 2023, 6.15 – 7.15 p.m.

Free registration plus other tours and info at:
⟶ tours.ethz.ch/en

Image: Alessandro Della Bella

Welcome return: mint & pepper projects to promote young talent.

Image: ETH Library; ETH Zurich/Albert Krebs; Composition: Sergeant

○ Exhibitions

## extract

extract is the new exhibition space for ETH Zurich's collection and archive holdings. Visitors will find a curated selection of objects and documents, collated as an interdisciplinary show rather than an exhibition from any single collection. The inaugural exhibition will open in August with a look at the importance of biodiversity and what its loss means. Entrance is free.

Monday to Sunday, 10 a.m. – 5 p.m.
ETH Zurich, Zentrum campus, Main Building

Find out more at:
⟶ extract.ethz.ch/en/

○ Scientifica – Zurich Science Days

## What holds the world together?

With the motto"What holds the world together?", this year's Scientifica will focus on the tension between order and chaos on the macro and the micro scale. What are the forces that keep the world around us in balance? What ensures the stability of physical, biological or social systems? Such questions are of fundamental importance to researchers from all fields, irrespective of whether their focus is the atomic world, social networks, geopolitics or entire ecosystems.

Over the Scientifica weekend, ETH and the University of Zurich will open their doors and invite the public to come and experience science for themselves. As ever, the spotlight will fall on researchers and teaching staff eager to share their enthusiasm for science.

2 – 3 September 2023
ETH Zurich, Zentrum campus, Hönggerberg campus, UZH Zentrum and Irchel

Find out more at:
⟶ scientifica.ch/en/

○ Innovation workshop and experimental lab

## Startbahn 29

Located in the Switzerland Innovation Park in Zurich, the Startbahn 29 research lab is an amazing place for people to learn, offering direct access to research expertise and high-tech infrastructure, including the realm of robotics at ETH Zurich. Under the guidance of experienced researchers, children and young adults between the ages of 7 and 25 can learn about the fascinating world of the natural sciences.

Find out more at:
⟶ startbahn29.ch

○ Permanent exhibition

## Thomas Mann and his workplace

At the heart of this newly designed permanent exhibition is Thomas Mann's famous desk, which accompanied him throughout his years of exile. Together with his personal library and numerous objects from different cultures, it formed the creative backdrop to Mann's work. How did the writer, who spent his last years in Switzerland, produce his literary opus? And what were the tools and rituals that helped shape the writing process?

ETH Zurich, Zentrum campus, Main Building

Find out more at:
⟶ tma.ethz.ch/en/

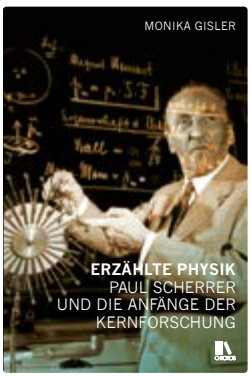
Image: Frank Blaser

○ Recommended reading

# The story of physics

**Paul Scherrer and the early days of atomic research**

Paul Scherrer lived many lives. As a successful young scientist, he quickly rose in prominence and was soon mixing with some of the most illustrious names in physics, including Wolfgang Pauli, Albert Einstein and Werner Heisenberg. A gifted teacher at ETH Zurich, he inspired several generations of students. He was also a diligent advocate for his own field, helping to position physics as one of Switzerland's leading scientific disciplines in the 20th century.




As President of the Swiss Atomic Commission and co-founder of CERN, Scherrer was extremely adept at generating public interest and raising funds for research. Yet some aspects of his life are less well known. During the war years, for example, he helped Jewish refugees find refuge at ETH, and he also supplied the American secret service with information. Monika Gisler describes Scherrer's work and tells the story of atomic physics. Her book also debunks a number of myths surrounding Scherrer and any nuclear ambitions Switzerland may once have harboured.

Chronos Verlag
ISBN 978-3-0340-1714-5
260 pages (in German)

Image: Chronos Verlag

# OUT OF FOCUS

Water, as seen through the eyes of illustrator Michael Meister

**IMPRINT** **Publisher:** ETH Alumni / ETH Zurich, ISSN 2235-7289 **Editorial team:** Corinne Johannssen, Karin Köchle (co-lead), Anna Janka, Michael Keller, Nicol Klenk, Florian Meyer, Peter Rüegg, Felix Würsten **Contributors**: Santina Russo, Samuel Schlaefli **Advertising administration:** ETH Alumni / ETH Zurich **Advertising management:** Fachmedien, Zürichsee Werbe AG, Stäfa, info@fachmedien.ch, +41 44 928 56 53 **Design:** Crafft AG, Zurich **Printing and Proofreading:** Linkgroup AG, Zurich **Translation:** trawo-Übersetzungen; Clare Bourne; Gena Olson **Accessible PDF:** Manu Heim, Matija Pavic, Karen Rudd **Circulation:** 38,800 (German), 16,100 (English), published quarterly **Subscriptions:** CHF 20.– annually (four issues); included in full membership of the ETH Alumni association **Newsletter:** ethz.ch/news-signup **Orders and change of address:** globe@hk.ethz.ch and for ETH Alumni alumni.ethz.ch/myalumni **Contact info:** ETH Zurich: ethz.ch/globe, globe@hk.ethz.ch; ETH Alumni: globe@alumni.ethz.ch

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# Scientifica 23

*What holds the world together*

# The Zurich Science Festival

## 28 August – 1 September

Events in the city of Zurich

## Weekend of 2 – 3 September

Interactive exhibition, lab tours, and short lectures in the main buildings of UZH and ETH Zurich, as well as on the Irchel Campus and the Hönggerberg Campus.

*#scientifica23*

*www.scientifica.ch*

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