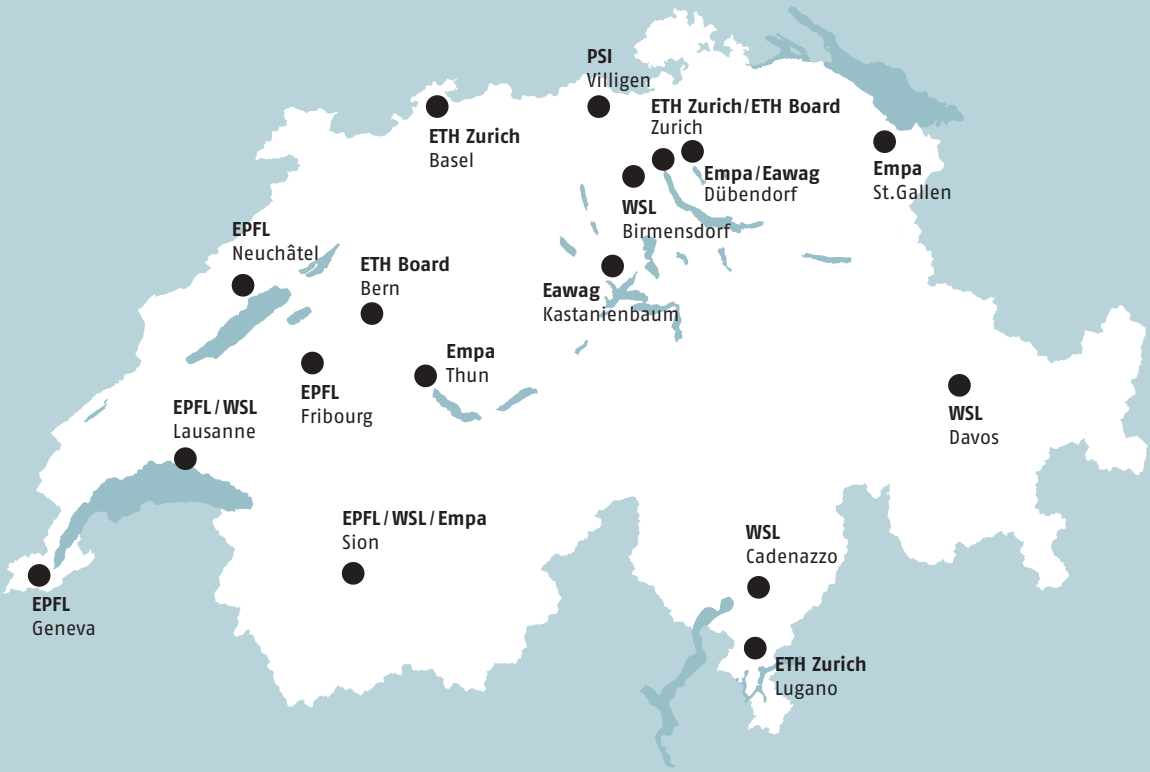
ETH BOARD

ANNUAL REPORT OF THE ETH BOARD ON THE ETH DOMAIN 2020

VISION

As a driver of innovation, the ETH Domain strives to strengthen the competitiveness of Switzerland in the long term and contributes to the development of society through excellence in research, teaching and knowledge and technology transfer. It endeavours to serve as an exemplary beacon on an international scale by assuming its share of responsibility for the management of urgent social challenges, the enhancement of the quality of life, and the long-term maintenance of our natural resources.



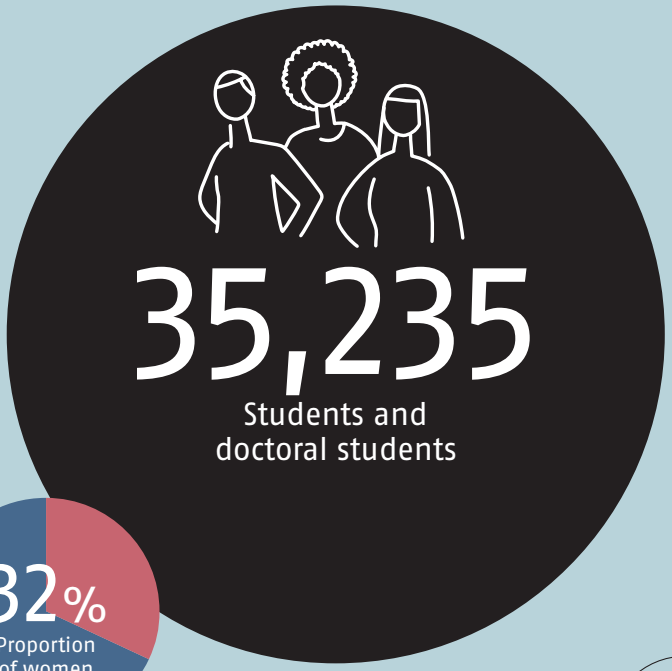
The ETH Domain and its institutions
Higher education, research and innovations of the highest standard: the ETH Domain provides these services with over 23,000 employees, more than 35,000 students and doctoral students and a pool of around 880 professors.

The ETH Domain consists of the two Swiss Federal Institutes of Technology ETH Zurich and EPFL as well as the four federal research institutes: the PSI, WSL, Empa and Eawag. The strategic leadership and supervisory body of the ETH Domain is the ETH Board. www.ethbereich.ch I www.ethrat.ch

ETH Domain

FACTS & FIGURES 2020

Students and doctoral students



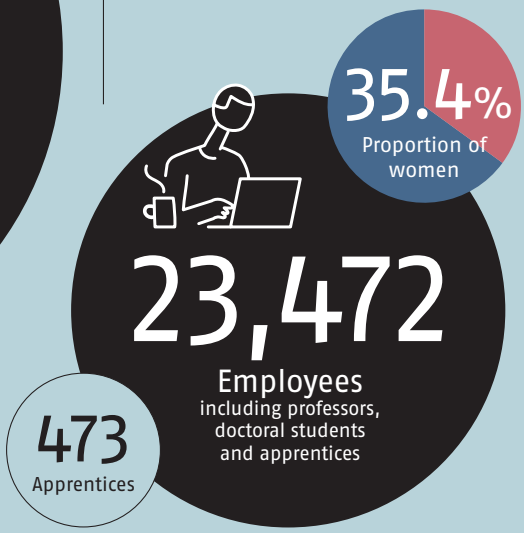
35,235
Students and doctoral students

32%
Proportion of women

Employees

with employment contracts (EC)

14,177 Scientific personnel
4,045 Technical personnel
3,890 Administrative personnel



35.4%
Proportion of women

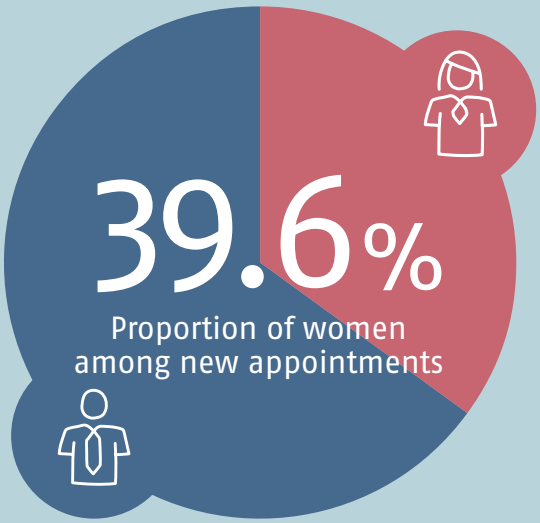
23,472
Employees
including professors, doctoral students and apprentices

473
Apprentices

Professors

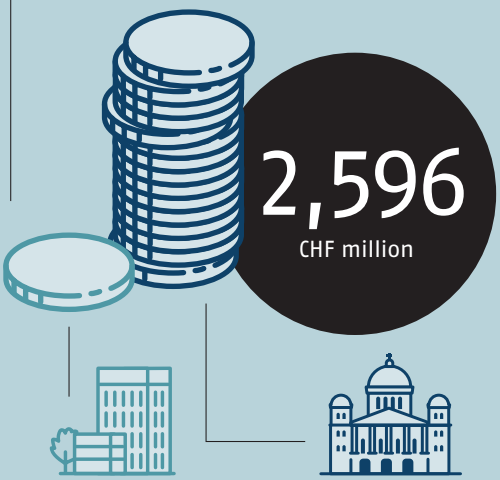
887

76 appointments, of whom
48 newly appointed persons



39.6%
Proportion of women among new appointments

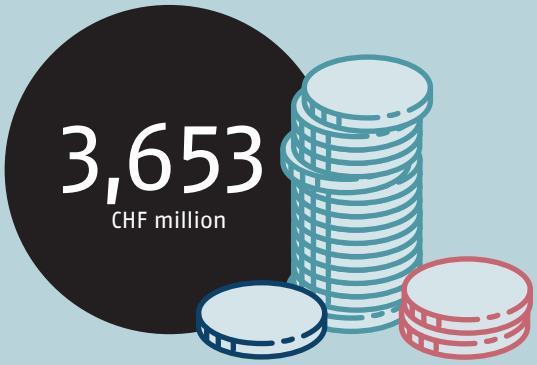
Total federal contribution[1]



Investment credit for buildings of the ETH Domain
CHF 241m

Federal financial contribution
CHF 2,355m

Expenses



Investments **15.9%**

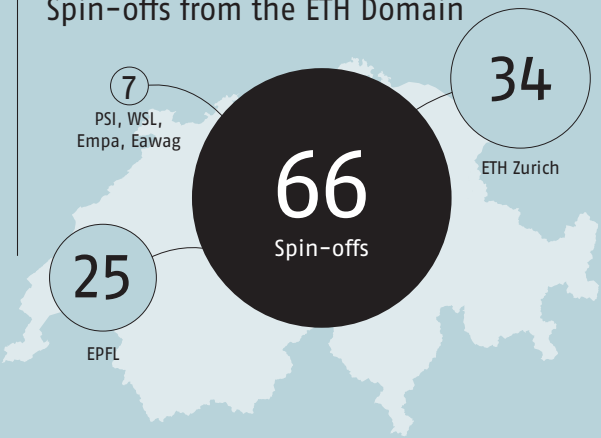
Personnel **65.4%**

Other expenses **18.7%**

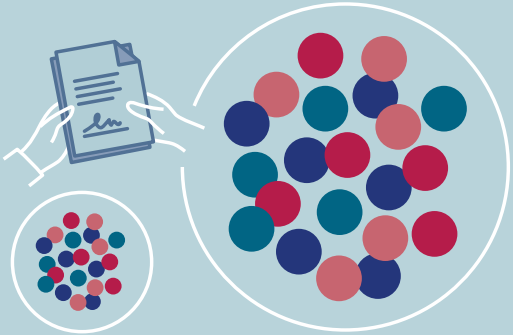
Knowledge and technology transfer[2]

310	invention disclosures
32	software notifications
217	patents
338	licences
66	spin-offs

Spin-offs from the ETH Domain



Number of cooperation agreements[3]



262
Public sector

610
Private sector

University rankings

	THE World Ranking	THE Europe Ranking	QS World Ranking	QS Europe Ranking
ETH Zurich	14	4	6	2
EPFL	43	13	14	6

[1] credits taking into account the expenditure ceiling
[2] see also p. 93
[3] with a volume of at least CHF 50,000 each

Annual Report of the ETH Board on the ETH Domain 2020

Financial Report:
www.ethboard.ch/financialreport2020

Table of contents

PSI: SLS 2.0 and HIPA

Brilliant research for brilliant light

With more intensive X-rays, scientists are making ever smaller structures visible. In order to remain competitive with the best facilities worldwide in the future, PSI's Swiss Light Source requires an update of the existing large-scale research facility.

Empa: Urban Energy Systems

"We are modelling the energy city of the future."

Buildings, districts and cities currently often have outdated energy systems in place. Homes must be made more energy-efficient and districts need to be supplied with renewable energy. In cities, the aim is to turn energy production and mobility into sustainable systems.

WSL: Energy Change Impact research programme

"We have to ask some uncomfortable questions."

All human activities affect the landscape and ecology, even if we stop using nuclear energy and rely on renewable energy. The joint Energy Change Impact research programme of WSL and Eawag provides precise data.

Eawag: biodiversity research in an interdisciplinary environment

Everything is interconnected – many losses are irreversible

Biodiversity on Earth is declining dramatically. Eawag has always had a great tradition of supporting research on biodiversity with modern research approaches and a highly interdisciplinary environment which is almost the only one of its kind worldwide.

FOREWORD

Since February 2020
President of the ETH Board:
Michael O. Hengartner
› Ruben Wyttenbach/
ETH Board

Dear Readers

It is impossible not to mention the coronavirus pandemic in an annual report for 2020 because it has changed all of our lives to such a great extent. In the ETH Domain, I am thinking in particular of the students. From one day to the next, they were only allowed to follow lectures online and no longer had access to the buildings and the campuses of the two Federal Institutes of Technology. Personal contact with study colleagues on site completely fell by the wayside. The home – usually a group of people sharing a flat, a student hall of residence or a room in their parents' house – became cramped. However, I am also thinking of all the employees of the ETH Domain who were in a similar situation: working from home and virtual team meetings instead of shared coffee breaks. It was a great challenge to reconcile work and family life when kindergartens and schools were closed and the children were at home.

Many of these students, doctoral students and employees in the ETH Domain have nevertheless – or precisely for this reason – made important contributions in numerous projects, in order to help manage the coronavirus pandemic. For example, students launched online platforms that helped healthcare institutions find volunteers and support staff. Researchers in the ETH Domain tested the quality of masks,

analysed the structure of the virus, detected it in the waste water or developed the SwissCovid app on behalf of the Federal Government. They were available to the media and authorities for questions about the importance of aerosols, the so-called R value, the economic impact of the pandemic or where and how the virus spreads most.

The Swiss National COVID-19 Science Task Force played a special role. Originally developed as an idea from within the ETH Domain, the Swiss ERI actors, the Swiss National Science Foundation, swissuniversities and the Swiss Academies of Arts and Sciences, were given the mandate from the Federal Government to advise authorities with scientific findings, in order to support them in their decision-making. This cooperation between science and politics is not always conflict-free, as different systems and understandings of roles meet. However, I am convinced that it is fruitful and profitable for both sides. I hope that this cooperation will also be deepened and institutionalised where other issues are concerned, be it in relation to the climate and environment, digitisation or health.

Switzerland can be proud of the ETH Domain – and of its education and research system as a whole. During this extraordinary period, numerous scientists have been enormously committed to the benefit of the general public. The Swiss ERI players have shown that it is worthwhile investing in high-quality teaching, research, knowledge transfer and technology transfer, and respecting the autonomy of these actors – just as politics and society have always done. Many thanks for that!

Zurich / Bern, January 2021

Michael O. Hengartner,
President of the ETH Board

The ETH Board reports on the ETH Domain

SCIENCE IN THE YEAR OF THE PANDEMIC

The coronavirus pandemic shaped the current reporting period like virtually no other event before it. Maintaining teaching and research activities under the influence of the epidemiological emergency was a major challenge for all institutions of the ETH Domain. Numerous research activities and technological developments in 2020 also focused on combating COVID-19. A multinational scientific network and close links to industry proved once again to be valuable foundations where this is concerned. Providing scientific advice to political decision-makers on dealing with the crisis situation was also especially important in the year of the pandemic.

"Switzerland remains a leading nation in terms of education, research and innovation, taking advantage of digitisation." With this premise, at the beginning of 2020 the Federal Council passed the Dispatch on the Promotion of Education, Research and Innovation (ERI Dispatch) for the period from 2021 to 2024. It applied for a budget of just under CHF 28 billion for the entire period. In the context of the parliamentary debate on the ERI Dispatch between the summer and late autumn of 2020, the National Council and Council of States also made it clear that they support the idea of ensuring that Switzerland remains one of the world's leading nations in the fields of education, research and innovation. In view of the extraordinary expenditure approved at the same time for the support measures of the Federal Council due to the coronavirus pandemic, this clear commitment to ensuring that Switzerland remains an education and research hub should be rated especially highly. The visibility which science was given during the crisis and the recognisable significance of strong education and research institutions when faced with unknown and urgent challenges certainly also played a role here.

Teaching and research under the influence of the COVID-19 virus

The switch to completely digital lessons was successfully implemented at ETH Zurich and EPFL following a smooth and very short transitional period. The policy of encouraging digital teaching methods like "flipped classrooms", which had already been in place for an extended period, made a significant contribution to the efficient organisation of distance learning (see p. 51 f.). Within a very short space of time, researchers also reacted to the occurrence of the new COVID-19 virus and launched numerous projects. Within the ETH Domain, these include, for example, research projects on possible vaccines, ventilators, equipment for test procedures, masks or detecting viruses in waste water (see e.g. p. 14 and 66). Researchers from the ETH Domain are also involved in the national research programme entitled NFP 78 "Covid-19", which was launched at the end of April 2020, where they are working on several projects.

What Martina Hirayama, State Secretary for Education, Research and Innovation, emphasised in sum-

From mid-March 2020, the ETH Domain also switched to emergency mode. The campuses of the institutions – the image shows a lecture hall on ETH Zurich's Zentrum campus – were closed for normal operations and were only allowed to be entered in exceptional cases.
› Nicola Pitaro/ETH Zurich

mer at the informal EU ministerial meeting on research and innovation applies in this respect: bottom-up research based on excellence has the potential to provide rapid and innovative responses to crises. She also pointed out that cross-border cooperation and facilitating an exchange of ideas between researchers are key factors in a joint response to crisis situations such as that of the coronavirus pandemic.

Global crisis – international research

The fact that research on the COVID-19 virus within the ETH Domain also has an international dimension goes without saying. The development of the SwissCovid app is a good example of this. SwissCovid, the official app of the Federal Council, is – together with contact tracing and systematic testing – an important measure for combating the COVID-19 virus. Assistant Professor Carmela Troncoso, from EPFL's Security and Privacy Engineering Laboratory, is one of the leading brains behind the application. She worked in a quickly formed, interdisciplinary team which had all the necessary skills. It comprised over 30 researchers from different institutions in eight European countries.

The good European and international cooperation is based on long-standing relationships and networks. Research programmes like Horizon Europe make a significant contribution to creating and expanding them. For the ETH Board and the institutions of the ETH Domain, full association with the European Union Framework Research Programmes for the period from 2021 to 2027 is of key importance. Even in the reporting period, the institutions of the ETH Domain once again successfully secured ERC grants in the context of the current Horizon 2020 programme (see p. 54).

In addition to Horizon Europe, the European Union also plans another edition of the Erasmus education programme from 2021 onwards. International cooperation and mobility in education contribute to the excellence and competitiveness of the Swiss education system and are given a high status by the ETH Board. It is therefore calling for full association with the Erasmus programme for the period from 2021 to 2027.

From research to practice

During the crisis, it also became especially clear how valuable the close partnership with industry is which the institutions of the ETH Domain have built up over the years. The transfer of knowledge and technology is a keyword where this is concerned. Against the background of the pandemic situation, researchers from Empa, ETH Zurich and EPFL succeeded within a very short space of time in developing innovative mask concepts for efficient protection against viruses and technologies for reusing protective materials in the context of the Innosuisse reMask project. They cooperated with Spiez Laboratory and a national consortium with representatives from the healthcare sector and industry. The approximately 50 industrial partners involved prove in an impressive way just how comprehensive the joint effort was.

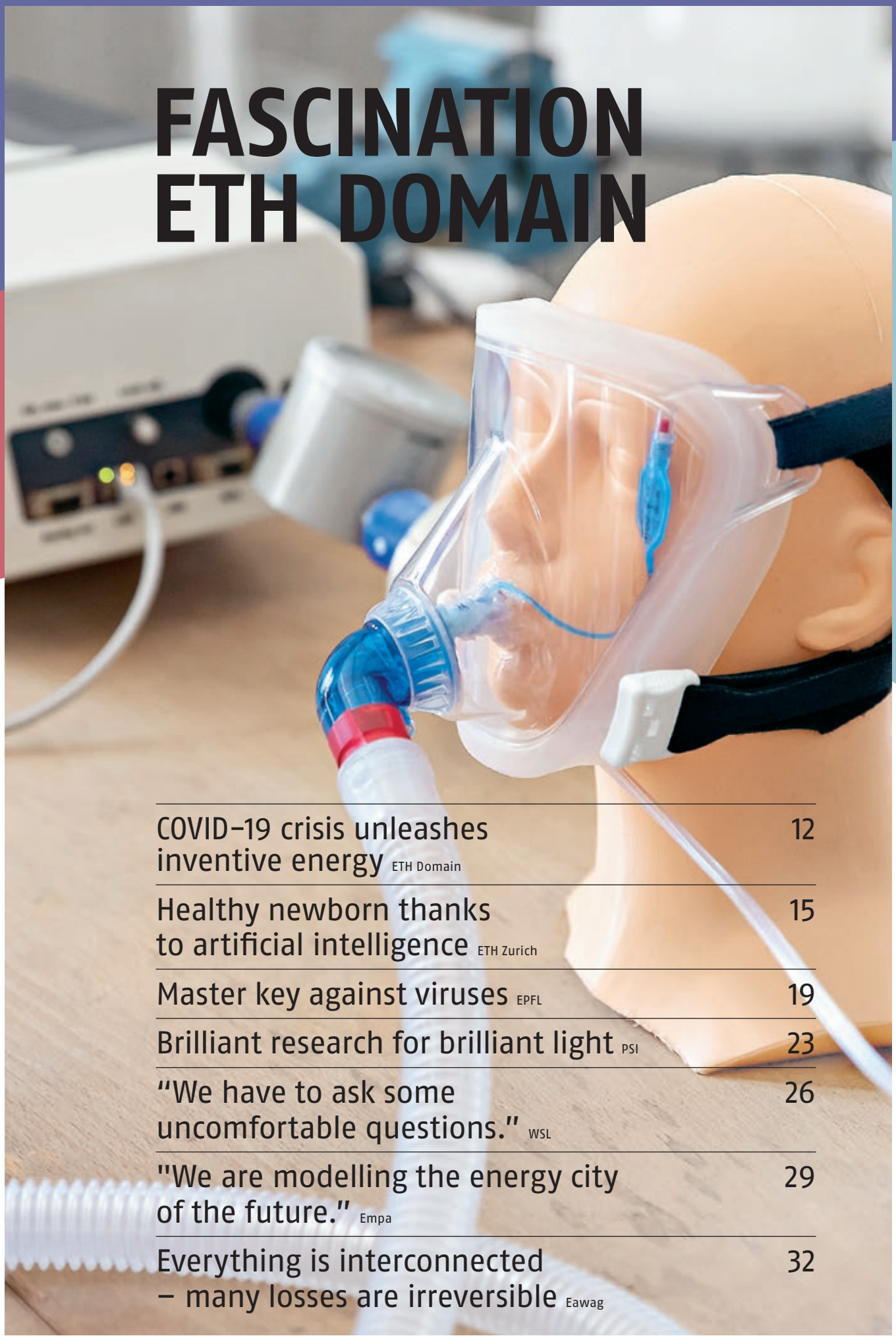
Even where other areas of innovation are concerned, it is possible to state that cooperation with businesses was successful in 2020. For instance, a similar number of patents, licences and cooperation agreements were reported as in the previous year and

and there was even a new record with 66 spin-offs foundations. The above-average success of such spin-offs and the high number of jobs created as a result were proven in the reporting period by a study conducted by the University of St.Gallen (see also p. 18).

Dialogue between scientists and politicians
One important contribution of science was ultimately in establishing the Swiss National COVID-19 Science Task Force. It supports the political authorities and decision-makers by providing them with information on which to base their decisions from the perspective of academics and researchers. The foundation of the Task Force had been proposed in March 2020 at the initiative of scientists and with the involvement of the ETH Board after there had been an exchange among researchers at an early stage and they wanted to contact politicians.

Responsible science includes getting involved in the political negotiation process in an advisory capacity. At the same time, the different roles must be clearly defined. The Task Force is an independent expert panel which makes scientifically sound recommendations. One of the basic principles of science lies in constantly questioning answers and solutions and developing them based on the latest findings. Mutual understanding for the different roles and working methods of scientists and politicians forms the basis for effective cooperation. In this sense, the current crisis is also a learning field, in order to establish a good form of exchange and to create a basis of trust for dialogue with a view to dealing with other issues and future crises. The issues of national and global importance where scientific expertise is highly relevant in aiding policy-making certainly include climate change and sustainability. The ETH Domain also wants to get deeply involved in this area and make its contribution.

FASCINATION ETH DOMAIN



ETH DOMAIN

THE CORONAVIRUS CRISIS UNLEASHES INVENTIVE ENERGY

A new virus is taking over the world. In March 2020, Switzerland was faced with an "extraordinary situation", and the second wave started sweeping across the country from October onwards. However, for many researchers in the ETH Domain that was no reason to despair, but rather an appeal and motivation to put their problem-solving skills to good use by tackling current and urgent challenges.

70
About 70 experts are active members of the Task Force. sciencetaskforce.ch

A new type of respiratory disease spread like wildfire all over the world from a seafood market in the city of Wuhan, which is located in central China and has more than 11 million inhabitants. In Switzerland, the Federal Council declared an "extraordinary situation" in mid-March 2020 due to the coronavirus pandemic. Whereas schools and businesses were forced to close and public life virtually came to a halt, the research community in Switzerland went beyond the call of duty. Numerous scientists are committed to doing their part to help overcome the crisis.

Minimising damages and costs

"It is an exceptional privilege for me to chair the national scientific task force," says Martin Ackermann. As a Professor of Microbial Systems Ecology at ETH Zurich and Head of the Department Environmental Microbiology at Eawag, he is interested in the fundamental questions of evolution. Together with his group, he is investigating, for instance, how genetically identical bacterial cells differ in their behaviour. Superficially, this has nothing to do with the occurrence of infection with the new virus. However, whoever takes a closer look will notice that the methods of mathematical biology and interdisciplinary cooperation play a major role where both issues are concerned.

The independent expert panel, which advises and supports the federal government and cantons, is made up of about 70 researchers. In ten different groups, they develop basic scientific principles on issues ranging from the prevention of transmission to economic effects and modelling of the number of beds in intensive care wards. Professor Ackermann was a founding member of the task force, and he has been leading it since August. Even though his new duty is very time-consuming, he gets a lot out of it. "It impresses me how constructively people work together." He says that he noticed that in public debates, economic and health-related well-being are often presented as being opposing poles. However, he adds, the task force members agree that the objective must be to minimise both health-related damages and societal costs. "The lower the case numbers, the greater the economic freedom," says professor Ackermann.

Newly invented contact tracing technology

Whoever wants to keep case numbers low must be able to break the virus's transmission chains. Contact tracing plays an important role here. Southeast Asian countries like Taiwan or South Korea have found an effective response to the pandemic by quickly locating and isolating anyone who was in the vicinity of an infected person. "However, as part of these procedures, these countries also resort to using data which should remain confidential from a privacy perspective," says Carmela Troncoso, Computer Science Professor at EPFL. "We asked ourselves what data is absolutely essential for contact tracing and then reinvented the technology within six weeks, so that only this data is collected."

"It wasn't just Switzerland which adopted our privacy-focussed approach, but also numerous other European countries."

› Carmela Troncoso, Computer Science Professor at EPFL

"It is an exceptional privilege for me to chair the National Science Task Force."

› Martin Ackermann, Professor of Microbial Systems Ecology at ETH Zurich

The new proximity-tracing protocol, which professor Troncoso designed with her colleagues, is called DP3T ("Decentralised Privacy-Preserving Proximity Tracing"). DP3T is based on regularly generated random IDs which are exchanged between smartphones via Bluetooth. During this process, that data remains stored in the user's phone. "We advised both Apple and Google on implementing the new Bluetooth interface," says Srđjan Čapkun, Professor at the Institute of Information Security, who was involved in the development of DP3T in the capacity of Director of the System Security Group at ETH Zurich. "The protocol is now used by the Federal Office of Public Health's SwissCovid app, but numerous other European countries have also adopted our approach," says Professor Troncoso. Her persuasive argument: the new technology ensures that nobody can access personal information (such as GPS location data), so that neither Apple nor Google, nor the authorities, can collect private data using the contact-tracing app.

11
new projects the PSI put together on the topic of COVID-19 within a few weeks.

Virtual briefings for avalanche bulletins
Necessity is the mother of invention. Thomas Stucki and his team from the avalanche warning service at the WSL Institute for Snow and Avalanche Research SLF in Davos had to come up with something new when they – like the majority of the Swiss population – were not allowed to go to their workplace during the shutdown. "The daily avalanche bulletins are a joint effort," says Th. Stucki. He adds that there are always at least three people on duty who meet for a fixed joint briefing at 3:00 p.m. every day to share their risk assessments. "Normally, we sit at the table with printed maps which we show each other during the meeting," says Th. Stucki.

He adds that during virtual Zoom briefings, they pointed out disputed points to each other on the screen and the majority of non-verbal communication was lost during this process. "Fortunately, the avalanche situation in March and April was favourable," says Th. Stucki. "This enabled us to practise the procedures while working from home." The avalanche warning service is now also equipped for a natural disaster which could cut the SLF off from the rest of the country and keep avalanche forecasters away from their workplace.

Light for 3D X-ray microscopy
The COVID-19 crisis also released inventive energy at the PSI. Even though most research institutions worldwide stopped operating during the pandemic, the large research facilities in Villigen, such as the Swiss Light Source (SLS), kept operating. The SLS supplies very bright X-ray light, with which, for example, the structures of proteins can be broken down to atomic level. Proteins are the most important "building materials" and the "molecular tools and machines" in all living systems, including the new SARS-CoV-2 virus. "Our employees benefited during the pandemic from the possibility of remote-controlled sampling using a robotic gripper arm at the measuring stations. In this way, researchers were able to analyse the structures of the SARS-CoV-2 proteins at any time", says Professor Gebhard Schertler, Head of the Research Division of Biology and Chemistry at the PSI. "At the same time, we the Board of Directors of the PSI, decided to launch a scientific programme on the topic of COVID-19."

Within a few weeks, researchers at the PSI initiated 11 new projects. For instance, a project was launched with the aim of using the bright SLS X-ray light to examine lung tissue samples of COVID-19 patients using a new X-ray imaging method developed at the PSI. If the illness is severe, the immune system attacks the lungs in a type of overreaction. As a result, mosaicked water inclusions form in the tissue, which make it difficult to breathe or even make it impossible to do so. "With the help of three-dimensional X-ray microscopy, we want to find out in greater detail what is happening and what can be done to avoid such lung damage if at all possible," says Professor Schertler.

Optical sensor for identifying SARS-CoV-2
The research group led by Professor Jing Wang at ETH Zurich and Empa also responded by realigning its scientific expertise. Until now, the team had mainly focused on measuring and analysing air pollutants like nanoparticles or aerosols and conducted research on, amongst other things, sensors which can detect

A new optical biosensor could measure the concentration of the virus in highly frequented places.

bacteria in the air. "We used these foundations and developed our optical sensor in such a way that it can specifically detect SARS-CoV-2 viruses in the air," says Wang. The new sensor consists of tiny golden structures – Professor Wang talks about "golden nano islands" – upon which he and his co-workers have grafted fragments of genetic material. These DNA fragments are complementary to the genetic sequence of SARS-CoV-2 and can therefore fuse with the single-stranded viral DNA.

When the famous double helix is thus formed, this also leads to a change in the distribution of electron clouds in the gold nanoparticles, which J. Wang and his team can measure using a spectrometer thanks to a quantum-mechanical effect (which is invisible to the human eye). "In addition, we can plasmonically excite the golden nano islands with a green laser light. This results in an increase in temperature, and virus sequences which do not match perfectly break away from the DNA fragments on the nano gold," says Professor Wang. "That is why our sensor can also distinguish the SARS-CoV-2 virus from the closely related SARS-CoV virus." Wang thinks that they will nevertheless have to overcome several other hurdles in development before it is possible to make reliable measurements in the air using the sensor.

Waste water analyses as a contribution during the coronavirus crisis

Researchers at EPFL have also developed a new detection method for the pathogen COVID-19 in cooperation with colleagues at Eawag. It might surprise you at first that you can make a contribution to overcoming the COVID-19 crisis with waste water analyses. "However, waste water analyses in Israel have, for example, already helped to contain an outbreak of the polio pathogen," says Professor Tamar Kohn, head of the Environmental Chemistry Laboratory at EPFL. "Worldwide, environmental monitoring is playing an increasingly important role in fighting diseases," adds Christoph Ort, Eawag research group leader in the Department of Urban Water Management.

Since the end of February 2020, employees of both research groups have been collecting waste water samples from Lausanne, Lugano and Zurich. "Initially, we were virtually flying blind. Only over time did we discover how we had to prepare and purify the samples in order to burst open the virus shell and examine the genetic material contained therein," explains Professor Kohn. Unlike the individual tests, which search for the genetic material of SARS-CoV-2 in smears of the mucous membranes of the throat, the waste water tests do not allow a conclusion to be drawn about individuals' infection with the virus.

Breaking new ground in times of crisis

Professor Kohn and Ch. Ort both think that in any case, only about half of the people infected excrete viruses through their faeces, which is why their analyses will by no means replace the PCR tests currently in use but rather complement them sensibly. This is because: "We can gain an overview of large sections of the population from waste water and can quickly identify where new disease outbreaks occur," says Professor Kohn. Ch. Ort has already been dealing with waste water analyses for more than a decade, a field which led a shadowy existence for a long time. "Our work was suddenly thrust into the limelight," says Ch. Ort. Now, the researchers are spending lots of time and energy on meeting the huge interest in the new coronavirus and answering the many questions they receive.

Overall, numerous scientists from the ETH Domain are demonstrating special commitment. By postponing their other research priorities, they are demonstrating their flexibility and contributing to overcoming the current crisis on many different fronts. That is why Switzerland's policy of maintaining a high-quality research landscape with sufficient funding is now paying off. It is at moments like this that Switzerland can rely not only on the researchers' excellent expert knowledge but also on their impressive ability to solve problems. They are used to dealing with uncertainties in their daily work and are especially capable of breaking new ground in times of crisis.

"It impresses me how constructively people work together."

– Martin Ackermann, Chair of the Swiss National COVID-19 Science Task Force and Microbial Systems Ecology Professor at ETH Zurich and Head of the Department Environmental Microbiology at Eawag

ETH ZURICH

HEALTHY NEWBORNS THANKS TO ARTIFICIAL INTELLIGENCE

The newly opened ETH AI Center is becoming an interdisciplinary hotspot for artificial intelligence. A new generation of AI researchers will be trained there, says Professor Andreas Krause, but also AI entrepreneurs who bring research to the economy. Such application-oriented research is already being conducted there today. Professor Julia Vogt, for example, bridges the gap between data-driven computer science and applied medicine.

Julia Vogt (left) is one of the professors at the new ETH AI Center. All of the university's activities relating to artificial intelligence are linked there.

Anyone who enters the term "artificial intelligence" (AI) in Google's search engine will receive almost twenty million hits. AI involves the automation of intelligent behaviour and machine learning through data and algorithms. At ETH Zurich, AI has been anchored in teaching and research for many years in a number of degree programmes: from the fundamentals of computer science, mathematics and information technology to applications in civil engineering, architecture, and natural and social sciences. It is also widely used in medicine or energy research, for example.

Now this growing expertise is being anchored in an even more interdisciplinary manner. The ETH AI Center of ETH Zurich, which links all activities of the university involving AI, started operating at the end of October 2020. It provides space to bring together experts on basic AI research and more application-oriented researchers in this field, so that they can also exchange ideas in person. The centre will also grow into an incubator for the foundation of AI start-ups and promote the transfer of knowledge gained to the economy. "We are creating a central hub for AI at ETH Zurich," says Andreas Krause, a professor at the Institute for Machine Learning and Chair of the ETH AI Center, "across all areas of research." The centre will also host members of the European AI research network ELLIS (ellis.eu) and visiting researchers in open labs.

"We are training a new generation of AI researchers who are leading the way in researching complex interdisciplinary AI-related issues."

› Professsor Andreas Krause (right), Chair of the ETH AI Center

A large number of researchers from 81 professorships and 16 departments will be working together – more than one hundred will be involved in the future. Meet one of them: Julia Vogt, a mathematician with a doctorate in computer science, now a professor of medical data science, who today uses AI to bridge the gap between data-driven computer science and applied medicine. She often deals with issues relating to the early detection of possible diseases, for example of the heart or in newborns. The first step is to bring together different data types, images, written or genetic information or time-related data in a single data room. "My research as a data scientist," says Professor Vogt, "and the questions of doctors and the interest of medical professionals in obtaining additional findings which help them to diagnose and treat diseases from the most varied types of patient data are closely linked." The scientist initially develops a model based on the clinical knowledge of the medical professionals concerned. This is made available to the doctors via an app to collect the necessary data. At the push of a button, they then receive information about the risks associated with patients' diseases, for example.

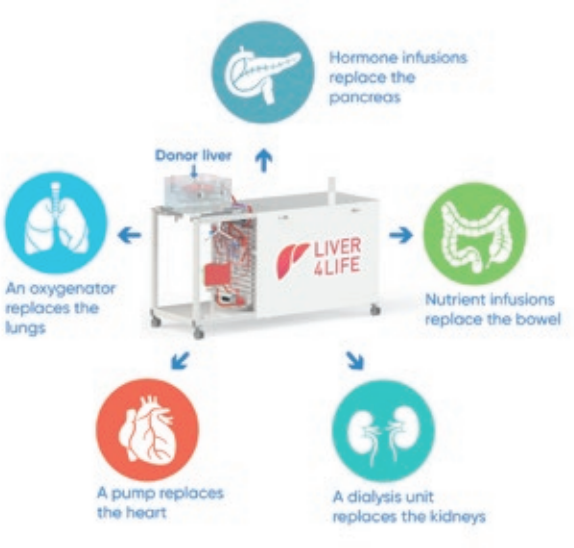
The projects of Professor Vogt are currently at the research stage. For example, the probability of newborns developing jaundice. If recognised early, this can be easily treated with light therapy. The app, developed in close collaboration between AI researchers and medical professionals, can already predict whether a disease is likely to occur 48 hours before the first symptoms emerge using only four indicators. Another application is the early detection of heart defects in newborns. From a large number of ultrasound images, in which the small heart was recorded from various standardised angles, Professor Vogt finds signs of possible heart defects. These help doctors to detect anomalies earlier. These are examples of science-based AI applications in medicine that – once certified for commercial use – have the potential to have a positive and direct effect on doctors' daily work and patient health.

Professor Krause, Chair of the ETH AI Center, wants to train the next generation of top AI talents, "outstanding researchers who are doing groundbreaking work and are addressing pioneering interdisciplinary AI-related issues." It is not only a question of applying existing AI methods, but also of developing them in close cooperation with users. For instance: What must neural networks look like to solve chemistry problems? Or: How do reinforcement learning algorithms need to be designed in order to be able to use large amounts of data effectively and safely in the context of Industry 4.0 or the Internet of Things? There is a lot of potential for practical applications. This is why the centre is also open to industrial partnerships. But that's not all: "We also train the new AI entrepreneurs there, who are to bring marketable research to start-ups and companies," said Professor Krause.

Breakthrough in transplantation medicine

The perfusion machine replaces the functions of various organs in order to keep the liver alive outside of the body.
› USZ

When the "Liver4Life" project started in 2015, a donor liver could only be kept outside of the body for a maximum of 24 hours. In 2020, this period was extended to seven days. This makes it possible to treat the liver before the transplant, which should save many people's lives. In order to provide the perfect conditions for the donor liver, the novel perfusion machine mimics the human body as accurately as possible. The heart is replaced by a pump, the lungs by an oxygenator, the kidneys by a dialysis unit and so on. A multidisciplinary team of researchers from ETH Zurich, the University of Zurich and the University Hospital Zurich are working together on "Liver-4Life".



ETH Zurich receives Swiss Energy Prize

The Swiss Federal Office of Energy has awarded the Swiss Watt d'Or 2020 energy prize to ETH Zurich for its dynamic underground storage system at the Hönggerberg campus. With over 12,000 students and staff and more than 30 buildings, the campus is an urban district in its own right. Each year, it consumes nearly 77 GWh of energy, about 22 GWh of which are used for heating. In 2013, ETH Zurich began operating its Anergy Grid with an underground storage system to heat and cool energy-efficiently and sustainably, as well as to reduce CO_2 emissions. Excess heat or cold are stored in water-filled probes 150 to 200m below ground until they are needed again. In order to heat buildings, heat is extracted from the storage system and cold is added. This process is reversed for cooling.

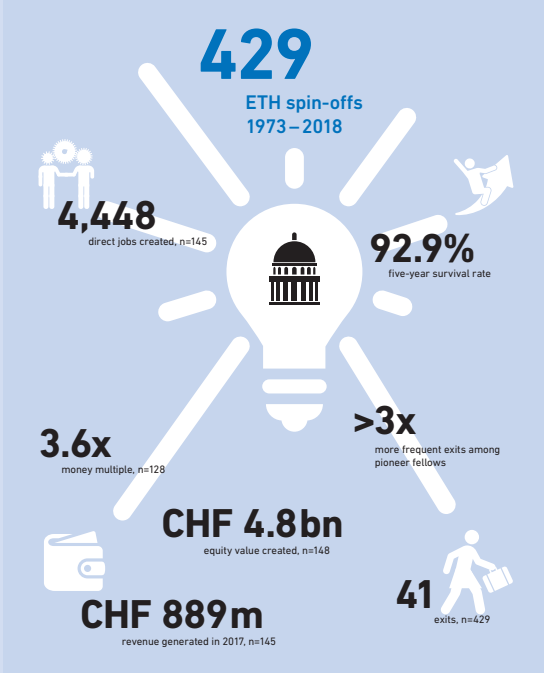
Burying intelligence underground: the Anergie Grid below the Hönggerberg campus can be visited by anyone interested.
› Alessandro Della Bella/ ETH Zurich

Two additional vice presidents strengthen ETH Zurich

Since 2008, the ETH Zurich Executive Board had comprised five members. In the meantime, competition has become fiercer and society's and politicians' expectations of the university have risen. Furthermore, the number of students has more than doubled since 2000 and the number of employees and ETH spin-offs has continuously increased. In order to strengthen the leadership culture and personnel development and to consolidate its position as a driver of innovation in Switzerland, ETH Zurich expanded its Executive Board: Julia Dannath-Schuh was appointed as the new Vice President for Personnel Development and Leadership, and Vanessa Wood as the new Vice President for Knowledge Transfer and Corporate Relations.

Vanessa Wood (left), new Vice President for Knowledge Transfer and Corporate Relations and Julia Dannath-Schuh, new Vice President for Personnel Development and Leadership.
› Markus Bertschi/ETH Zurich

How ETH Zurich spin-offs strengthen the Swiss economy



The approximately 500 spin-offs of the ETH Zurich play a key role in the transfer of knowledge to the Swiss economy. In order to estimate the performance and economic added value of these ETH spin-offs, the University of St.Gallen has now performed a detailed analysis of them for the third time. This has shown that as well as generating considerably more jobs on average than other Swiss start-ups, they are also acquired more frequently. The group of 145 ETH spin-offs analysed as part of the study was shown to have created a total of 4,500 full-time equivalent (FTE) jobs. Their overall equity value is almost CHF 5 billion. The ETH Zurich spin-offs generated almost CHF 900 million in revenue in 2017, making them an attractive investment option. The study also shows that they are more likely to make an exit and that their five-year survival rate is 93%. ETH's support is a decisive factor in the spin-offs' success, which is why the university wants to further improve its offer.

The growth in numbers: the graphic shows some results of the study.
› ETH Zurich

Prestigious award for pioneer of proteomics

Ruedi Aebersold, Professor Emeritus of molecular systems biology at ETH Zurich and the University of Zurich, is the 100th person to be awarded the Swiss Science Prize Marcel Benoist which includes prize money of CHF 250,000. R. Aebersold was honoured for the part he has played in founding and advancing the field of proteomics, a branch of biology that is seen as the foundation of the personalised medicine of tomorrow. The researcher took on the task of finding a way to record all the proteins of a cell or living organism qualitatively and quantitatively at a given point in time (the proteome), thereby transforming our understanding of organisms and biology in general.

The Bachelor of Medicine at ETH Zurich proved successful

Since autumn 2017, ETH Zurich has been offering 100 places to study human medicine each year. The Bachelor's degree course was developed from scratch and initially launched as a pilot project for the five annual cohorts from 2017 to 2021. The first medical students graduated with a Bachelor's degree in 2020. And now it is clear that almost all the new graduates will continue their medical training as expected at one of the three clinical partner universities in Lugano, Basel or Zurich. The university has taken this into account and ended the pilot project more than a year earlier than planned and will continue the degree course as a normal programme from January 2021.

Ruedi Aebersold received one of the highest honours that exist in Switzerland for scientists.
› Gian Marco Castelberg/ ETH Zurich

A physical lecture with virtual reality: students on the Bachelor of Medicine degree course at ETH get to grips with VR headsets.
› Jürg Goldhahn/ETH Zurich

EPFL

MASTER KEY AGAINST VIRUSES

Francesco Stellacci sees the world through the eyes of a materials scientist who is breaking new ground in virus research. The EPFL professor is looking for the formula for a broad-spectrum virus killer. His aim is not to contain the pathogen but rather to destroy it permanently. Sugar molecules are the means he intends to use for this purpose.

"In 2050, the risk of a new virus breaking out will be five times as high as it was a century beforehand."

› Francesco Stellacci, Professor and Head of the Supramolecular Nano-Materials and Interfaces Laboratory

When Francesco Stellacci talks about his research, every word is an expression of the enthusiasm of the professor who is the Head of the Supramolecular Nano-Materials and Interfaces Laboratory (SuNMiL) at the EPFL. He was born in Italy, and is thus always making gestures with his arms and hands when he speaks. As if this weren't enough, in the interview he used items on his desk to help make his point. The cover of his AirPods represented the virus.

It's all about viruses here, and not only since COVID-19 has been holding humanity hostage. Ten years ago, when Professor Stellacci came from the Massachusetts Institute of Technology (MIT) to EPFL, the materials scientist wanted to research ways of helping people in need. He initially started looking for a medicinal product to treat viral diarrhoea, an illness which kills thousands of children every year in developing countries.

Infectious diseases, both viral and bacterial, are one of the leading causes of death in developing countries. However, in the pre-COVID-19 era, the lion's share of medical research funding went towards cancer or Alzheimer's research. There was virtually nothing left over for infectious diseases – and the larger of the two small remaining pieces of the pie went towards research into bacterial diseases. Viral infections were the Cinderella of research. Therefore, Professor Stellacci became convinced that he should expand his project on a larger scale. It was now about finding a single killer for a large number of viruses. He substantiates his claim by saying: "Since the 1970s, we have been confronted with a new virus roughly every four years: HIV, Ebola and Zika." Today, we have COVID-19. There is no doubt in his mind that it will continue like this and that the pace will even pick up. In the 1950s, there were about two billion people in the world. Today, there are more than 7.5 billion of us, and this figure is expected to rise to 10 billion in thirty years from now. Since population density is a decisive factor in how quickly viruses can spread, it is possible to draw a logical, simple conclusion: in 2050, the risk of a new virus breaking out will be five times as high as it was a century beforehand.

Francesco Stellacci applies his knowledge about supramolecular nano-materials and interfaces in virus research. Here, too, the focus is on interactions on surfaces.

Therefore, it wasn't about focussing on eradicating a single species of virus, but rather the pathogen's genus itself. There simply had to be a way of developing a medicinal product, which renders every type of virus permanently harmless before it has the chance to penetrate the human cell via the cell membrane. After Professor Stellacci had ploughed through the scientific literature, it became clear to him that this possibility already existed. Put simply, sugar molecules – which also exist on the surface of cells where they exchange proteins – can attract viruses and the pathogen thinks it is in front of a cell. A clever ploy: they are merely sugar molecules. This method already produced some lasting successes in test tubes quite some time ago, albeit not in living creatures.

Whereas there are stable conditions in a test tube, in living organisms the protection of free-flowing sugar molecules falls by the wayside as soon as concentration levels drop. The virus is then still there, the cell is defenceless, and the infection cannot be avoided. Professor Stellacci looks at this problem through the eyes of a nano-material researcher, who studies many different effects on surfaces and knows that certain processes can become irreversible once they reach an advanced stage. For the virus in the body, this means finding a way to make it 'explode'. Professor Stellacci now picks up his AirPods cover with his left hand. He drums the fingers of his right hand on it, as if he wanted to make it burst. This is exactly what it is all about. His medicinal product puts the virus under increasingly severe stretching pressure until it bursts like a balloon – at that moment, the virus is rendered permanently harmless.

He has already successfully tested the medicinal product on mice. "But," he says, spreading his arms out wide, "there is still a long way to go." With research funding from the Werner Siemens Foundation, he is now able to start the comprehensive studies needed to reach the clinics with his compounds. He is convinced that his master key against viruses should be able to protect the young, healthy section of the population when the next pathogen emerges. In the form of a nasal spray, this new drug could prevent a shutdown or lockdown. However, this medicinal product will even be so effective that it can make the virus harmless across the whole population. Realistically, the role of such a drug will be to give us some time until a vaccine has been developed.

Designing vaccines from artificial proteins

Vaccines are the most effective measure for preventing the spread of infectious diseases. This is why a team of scientists at EPFL's Laboratory of Protein Design & Immunoengineering (LPDI) have developed a new computational approach to create artificial proteins, which showed the best results as functional vaccines. If a vaccine doesn't work well, it's usually because our immune system makes the wrong type of antibodies. The newly developed strategy with artificial proteins, on the other hand, shows the body's immune system which antibodies to produce.

EPFL's approach to safer and more effective vaccines.
› EPFL

Like real tissue: next-gen organoids

Bioengineers at EPFL have successfully created miniature intestines in a dish that match up anatomically and functionally to the real thing better than any other lab-grown tissue models. The biological complexity and longevity of this new organoid technology is an important step towards enabling drug testing, personalised medicine and perhaps, one day, transplants. Organoids quickly became one of the most cutting-edge tools of modern life sciences. The idea is to use stem cells to build miniature tissues and organs that accurately resemble and behave like their real counterparts. From research to drug development, organoids could complement animal testing by providing human tissues, thus expediting the lengthy journey from lab to clinical trial.

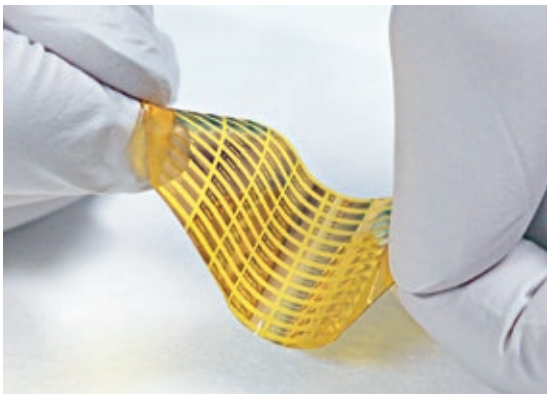
Keep smiling with a transparent mask

Because masks are a major obstacle to communication, a team of researchers from EPFL's EssentialTech Center and Empa has been working for the past two years on a transparent surgical mask made from a biomass-based material. Called HelloMasks, they are above all intended to replace the blue and green surgical masks currently used, thus making the contact between caregivers and patients less impersonal. In addition, the research team have founded a start-up called HMCARE (hmcare.ch) in preparation for the scheduled launch of the masks at the beginning of 2021. The research team wants to produce locally, here in Switzerland, to meet the surging demand for masks caused by the pandemic.

First fully transparent surgical mask
› Alain Herzog/EPFL

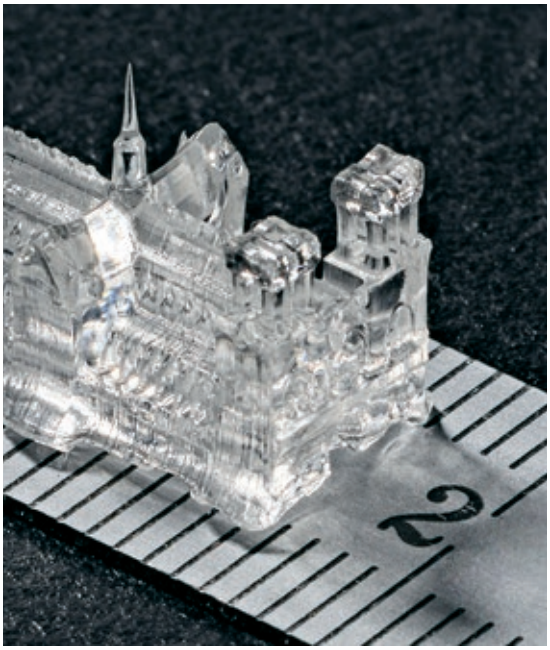
A nanoscale device that can see through walls

Researchers at EPFL have developed a nanodevice that operates more than 10 times faster than today's fastest transistors, and about 100 times faster than computer transistors. This new device enables the generation of high-power terahertz waves (THz). They can penetrate paper, clothes, wood and walls, detect air pollution and be used in treatment techniques like cancer therapy. THz waves are not widely used to this day because they are costly and cumbersome to generate. The new device can generate extremely high-power signals in just a few picoseconds which produce high-power THz waves.



The nanodevice can be implemented on flexible substrates.
› EPFL

Printing tiny, high-precision objects in a matter of seconds



A new method for 3D-printing small, soft objects
› Alain Herzog/EPFL

Scientists at EPFL's Laboratory of Applied Photonics Devices (LAPD) have developed a new, high-precision method for 3D-printing small, soft objects. The process takes less than 30 seconds from start to finish. It is ideally suited for medicine and biology, for instance to make soft objects such as tissue, organs, hearing aids and mouthguards. Conventional 3D printing techniques build parts layer by layer. The problem is that soft objects made that way quickly fall apart. With the new method, the laser hardens the liquid through a process of polymerisation. Depending on what they're building, the scientists use algorithms to calculate exactly where they need to aim the beams, from what angles, and at what dose. The system is currently capable of making two-centimetre structures with a precision of 80 micrometres. In a second phase, they should be able to build objects of up to 15 centimetres.

Maryna Viazovska wins the National Latsis Prize

The 2020 National Latsis Prize went to Maryna Viazovska. The young EPFL mathematics professor from Ukraine achieved a scientific breakthrough by solving the sphere-packing problem in 2016. For centuries, luminaries of mathematics made assumptions which could only be proven three-dimensionally in 1998 through huge computer calculations. M.Viazovska caused a sensation with her original and astonishingly simple calculation of the densest sphere packing in the much more complex 8th and 24th dimensions. Whereas work on these two dimensions had previously been based on hypotheses, Viazovska now provided the mathematical proof. Research results on sphere packing in high-dimensional spaces are used, for example, in troubleshooting signal transmission of mobile phones.

Andrea Ablasser wins the Leenaards Foundation's Science Prize

The Leenaards Foundation has awarded its 2020 Science Prize to a Lake Geneva region-based team led by EPFL Professor Andrea Ablasser, working in partnership with Professor Michel Gilliet from the Lausanne University Hospital (CHUV). Their project aims to gain an insight into the causes and effects of an overactive innate immune system in people with autoimmune diseases, starting with psoriasis, lupus and scleroderma. The project will involve three main phases: firstly, to gain an insight into the causes and effects of the immune system's hyperactivity; secondly, to develop new therapeutic strategies and thirdly, to test the beneficial effects of new STING-system inhibitors in vitro and in vivo, so that they can then be applied therapeutically.

Highly distinguished: EPFL Professor Andrea Ablasser (right) in her lab
› Alain Herzog/EPFL

Maryna Viazovska (left) – explorer of mathematics from EPFL
› Alain Herzog/EPFL

PSI

BRILLIANT RESEARCH FOR BRILLIANT LIGHT

With more intensive X-rays, scientists are making ever smaller structures visible. In order to remain competitive with the best facilities worldwide in the future, PSI's Swiss Light Source requires an upgrade of the existing large-scale research facility. With PSI developments, the project team of Mike Seidel and Hans-Heinrich Braun succeeded in designing this modernisation in the existing building in an energy and cost-efficient manner.

In the storage ring of the new SLS 2.0, the brilliance of the synchrotron light produced will be greatly improved by a new type of finely graduated magnet arrangement.

The two scientists have a lot in common. Both are physicists specialising in particle acceleration. Professor Mike Seidel still teaches this subject at the EPFL on a part-time (0.4 FTE) basis. Dr Hans-Heinrich Braun was already involved in the introduction of the X-ray free-electron laser SwissFEL in the capacity of project manager, which was commissioned in 2016 as a "scientific avant-garde" at the PSI. Now it's about similar things: the Swiss Light Source (SLS), which opened at the PSI in 2001, needs an update – for 20 years, the large-scale research facility with its powerful electron accelerator has been reliably producing extremely bright X-ray light which enables many different types of experiments and investigations in physics, materials science, biology, chemistry, or the environmental sciences.

However, scientists want to use increasingly intensive X-rays to reveal greater details that are either no longer recognisable with the existing accelerator system or can only be achieved within an unrealistic time frame. "An experiment, which until now lasted 40 minutes," says H.-H. Braun, "will in future take 60 seconds." A higher brilliance in the light also increases the resolution of the images, thus making dramatically small structures visible. At the same time, however, the amount of measured data to be stored and processed per experiment also increases massively.

"Thanks to the research conducted at the PSI, we now have a better understanding of the dynamics of electron beams. This helped us with the SLS 2.0. project."

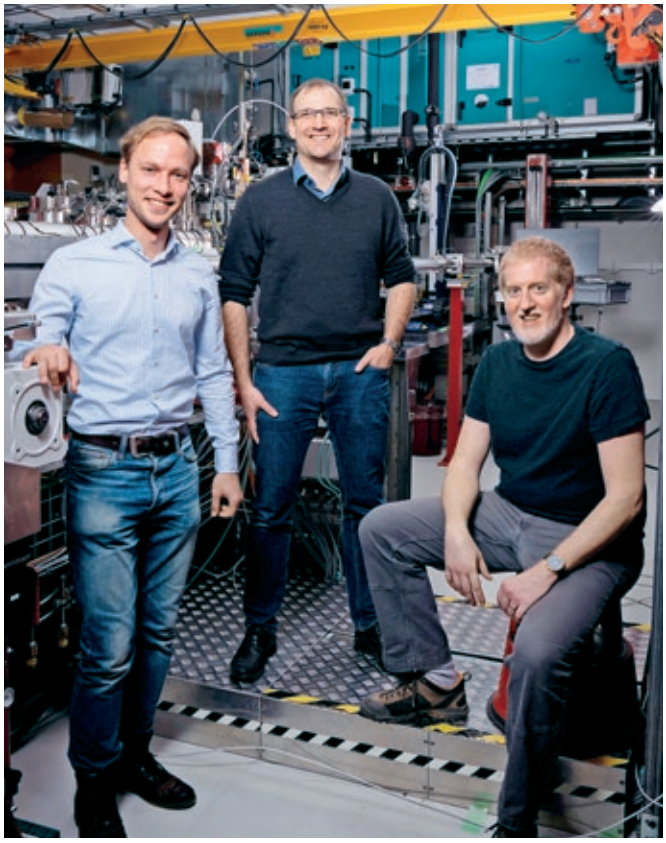
› Prof. Mike Seidel (left) and Dr Hans-Heinrich Braun

Now the SLS 2.0 project brings together Professor Seidel and H.-H. Braun: the former is Head of the Large Research Facilities division and is therefore responsible for the flawless operation of the world's highest concentration of accelerator-based large research facilities on the PSI site. The latter is project manager of SLS 2.0 and contributes his project experience gained during the construction of the SwissFEL to this complex further development of the SLS. The question for both of them was: in the existing building with the walls and ceilings made of wood and concrete, how can the large research facility be upgraded with a significant improvement in the brilliance of the light?

In the current SLS, electrons circulate which are accelerated to very high speeds. These tiny, negatively charged elementary particles race around at 99.999998% of the speed of light in the vacuum of the so-called electron storage ring. In an evacuated metal tube, the electrons are held on this curved path by magnets. This deflection of the electron beam creates the synchrotron light, which is directed from there to around twenty research stations within the facility. As light elementary particles, electrons produce intense, short-wave X-ray radiation with properties that are interesting for a wide range of applications in research.

The upgrade of the facility was aimed at implementing a further physical peculiarity permanently in SLS 2.0: if the electrons' abrupt changes in direction were to be converted into smoother curves in the new facility, this would lead to a higher concentration of circulating electron bunches, which result in more intense, more concentrated beams of light. The key for the accelerator physicists was the number and size of the magnets in the storage ring of the new SLS 2.0. Many small magnets, graduated in strength, change the existing electron path to one with many smaller angles. A Herculean task! The number of magnets and other components in the ring will be significantly increased, while tolerances for the particle beam itself and many parameters will be more demanding in the future. After many tests and detailed computer simulations, the PSI beam dynamicists found the solution in the form of a novel arrangement of the magnets. "It is the result of our improved understanding of the beam dynamics of these storage rings," says Professor Seidel. The diverse skills of the approximately 400 employees of large research facilities were another decisive factor. These range from the mechanical design to the generation of an ultra-high vacuum, the exact calculation of the magnetic fields and the prediction of the properties of the electron beam. "Given the complex nature of the work involved, one mistake is enough to stop the facility from running," said Professor Seidel.

Now the SLS 2.0 can be built: in December 2020, the Federal Government approved a budget of CHF 99m, with a further CHF 17m coming from PSI. The current facility is scheduled to be decommissioned in October 2023, and the SLS 2.0 is to be installed there by the end of 2024.



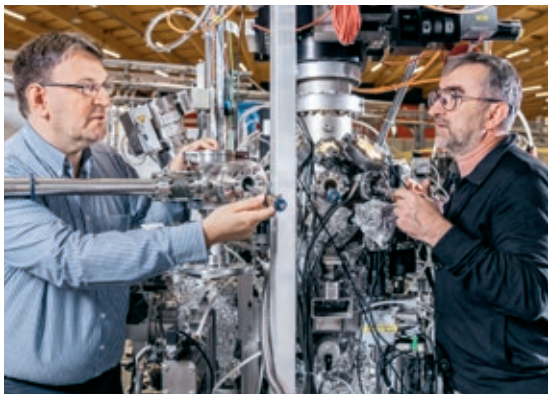
Three researchers at the Alvra experimental station at the X-ray free-electron laser SwissFEL are delighted about the successful sodium pump experiment.
› Mahir Dzambegovic/PSI

Elucidating the mechanism of a sodium pump

Rhodopsins are special proteins that are activated by light. They enable, for example, the visual process or regulate the day/night cycle. However, they are also a component of special pumps in cell membranes which transport substances like sodium ions out of biological cells. Researchers from the PSI were able to find out exactly how one of these sodium pumps works with the help of the large research facility SwissFEL. That is an important step towards improving the application of such sodium pumps in neurobiological research. If researchers succeed in using molecular biology techniques to install them in nerve cells, then it will be possible to block stimulus transmission using the light-driven pumps. The long-term goal is to gain a better understanding of neurological illnesses and to develop new therapies.

Customising an electronic material

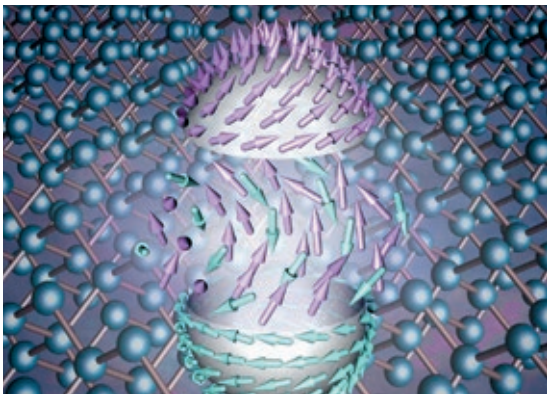
Researchers from the PSI collaborated with colleagues from Poland, the USA and France at the large research facility The Swiss Light Source SLS where they made fundamental findings about a promising material which could be suitable for future applications in data storage. Their experiments with strontium-iridium oxide, Sr_2IrO_4, investigated both the magnetic and electronic properties of the material as a thin film. They also analysed how these properties can be systematically controlled by manipulating the films. This study was made possible by an X-ray technique in which PSI researchers are amongst the world experts.



Thorsten Schmitt (left) and Milan Radovic at their experimental station at the PSI's Swiss Light Source SLS, where they performed their measurements on thin films of strontium-iridium oxide.
› Markus Fischer/PSI

Nanostructures with a unique property

In order to be able to store larger volumes of data in even smaller electronic components or process them more efficiently in the future, researchers are interested in magnetic structures which are as tiny as possible. One of these possible structures is called skyrmions which are nanostructures in magnetic materials. Until now, skyrmions were only known to exist in ferromagnetic materials. Researchers at the PSI have now also created antiferromagnetic skyrmions for the first time and proven their existence at the large research facility SINQ: The Swiss Spallation Neutron Source. Antiferromagnetic skyrmions are easier to control and therefore represent a decisive step towards their application as a data storage medium.



Skyrmions are nanostructures: tiny vortices in the magnetic alignment of atoms. This state is shown in the artist's impression above.
› Diego Rosales/PSI


WSL
"WE HAVE TO ASK SOME UNCOMFORTA-BLE QUESTIONS."

All human activities affect the landscape and ecology, even if we stop using nuclear energy and rely on renewable energy. Astrid Björnsen led the joint Energy Change Impact research programme of WSL and Eawag. It provides accurate data on the potential and availability of renewable energy in the country.

Ms Björnsen, you led the Energy Change Impact research programme. Are there problems associated with alternative energy sources? The implementation of the Energy Strategy 2050 requires a radical transformation of the current energy supply. This has some inherent risks and raises new questions that need to be researched. My boss told me: "You will take on the role of the spoilsport who has to critically examine the effects."

Supporters of the energy transition want to do something good for the environment. That is what we all want. A quote from The Goldfinch expresses the dilemma in a wonderful way: "Even the wise and the good do not always see the final result of their actions."

What do you mean by that? Humanity has invented great technologies that make life easier for us. However, every technology also has negative effects that we could not foresee and now need to correct. Based on our current knowledge, we should be capable of recognising the consequences of our actions and minimising the negative effects of the energy transition. We had to ask uncomfortable questions to reach that point.

For example? We must ask ourselves which landscapes we are prepared to sacrifice. Densely populated Switzerland does not have unlimited empty spaces in which it can build plants for the production of renewable energy. In addition, unspoilt landscapes and recreational areas are very valuable for both people and nature.

Do you have any answers? A nationwide survey conducted by WSL and ETH Zurich has shown that the population is mainly in favour of building new plants where infrastructure already exists. This also applies to the Alpine region.

Hydropower remains the most important renewable energy in the country. It will be expanded further in the future. A great deal of progress has been made in the area of hydropower, for instance to ensure that fish can pass through in spite of dams. Interdisciplinary research teams are working on other issues. For example, sediment transport management is a challenge, also because of climate change: the thawing of permafrost will release much more debris in the future.

So what now? Researchers from the WSL, Eawag and ETH Zurich are examining diversion tunnels for the debris. In Switzerland, there are currently ten operational sediment bypass tunnels near dams, such as the Solis Reservoir on the River Albula. It is about reducing the siltation of reservoirs and maintaining sediment transport. Artificially generated flood water supplies the underlying river with enough bedload onto which it can "vent its energy". This prevents the erosion of the banks and creates new habitats.

What other effects is climate change having on hydropower? An interesting question. Due to its geographical location at the Alpine arch, Switzerland remains a water reservoir. However, the glaciers are disappearing, leaving behind cirques or new lakes. Researchers are investigating the extent to which these could be used as water reservoirs.

What are you thinking about? Climate models forecast more summer droughts. A team of researchers is currently investigating possible multipurpose uses of water reservoirs. In addition to hydropower, agriculture, drinking water supplies and nature also make demands on the resource.

What role does biomass play? It is obvious that it should be used. Farmers produce large quantities of farmyard manure, and just under a third of the country is covered in forest. We could get more out of the forest. Low timber prices, an oversupply of low-quality storm-damaged timber and the high costs of the wood harvest make this an unappealing option. A more intensive use of energy can have an impact on the biodiversity of forests. Whether wood can be a sustainable resource in the long term must be carefully clarified. Climate change presents an additional challenge where this is concerned.

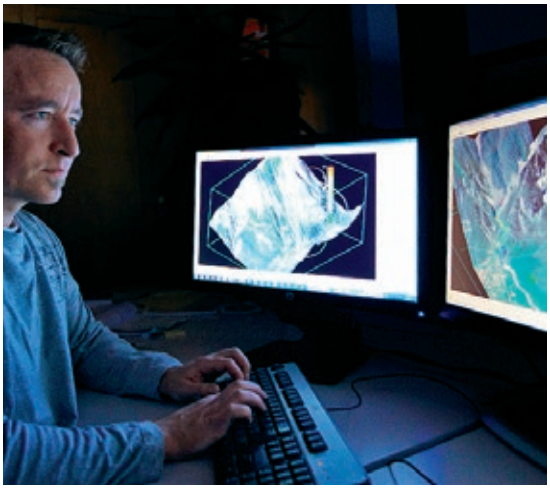
In what way? Although we know how forests will adapt to rising temperatures, our models do not show the effects of extreme periods of drought. The extremely hot summer of 2018, for example, took its toll on beech trees. If pests and storms are then also added to the mix, the availability of resources changes suddenly.

However, farmers reliably produce farmyard manure. Farmers are individualists, their farms are rather small and scattered, making it difficult to use the farmyard manure centrally. The energy transition is not just a technical challenge – it is also always about the people affected.

What are the results of your research programme? Accurate knowledge of the availability of renewable resources, such as biomass, water, wind and sun. We know how big the potential is and where and when it is available. In coordination with the scenarios for future energy requirements, this data enables well-founded, more cost-effective and more environmentally friendly planning.

How does this now get put into practice? My favourite topic! Researchers should increasingly keep an eye on the final result of their actions: put knowledge into practice. The early involvement of potential users, perhaps already while formulating research questions, makes it easier for us to transfer knowledge and technology at the end of the process. For this to happen, more resources – and by that I mean not only money, but also staff and time – would have to be made available. Swiss energy researchers have recognised this.

New research centre for climate change, natural hazards and extreme events in Davos



Calculate natural hazards and simulate extreme events: already today an important research topic with practical significance.
› Ralph Feiner

Global climate change is progressing and has a particularly strong influence on weather extremes and natural hazards in the Alpine region. This has social and economic consequences, as shown by the rock avalanche and subsequent debris flows in Bondo in the Bergell region. For this reason, the WSL, which is already firmly rooted in the Alpine region with the WSL Institute for Snow and Avalanche Research SLF, is building a new «Climate Change, Extremes, and Natural Hazards Research Center» (CERC, cerc.slf.ch) in Davos in cooperation with the canton of Graubünden, which will investigate the effects of climate change on extreme events in the Alpine region. Around forty employees will address issues such as early warning systems, mountain ecosystems, protection forests and risk communication. ETH Zurich is participating in two joint professorships – one in the field of Alpine mass movements and permafrost, and another on the effects of climate change on mountain regions. All participants have made their 2020 funding decisions. The centre, which will start operating on 1 January 2021, is secured for an initial period of 12 years.

Swiss National Forest Inventory: understand the Swiss forest

Every ten years, the WSL and the Federal Office for the Environment (FOEN) jointly publish a report on the results of the Swiss National Forest Inventory – and they did so in 2020 too. It shows that the Swiss forest provides better protection against natural hazards than in the last period, and that forest structures and tree species have become more diverse. These are pleasing developments, also in view of the increasing stress caused by drought and storms. The forest is plagued by insect infestations and diseases. In addition, forests at higher altitudes are often not thinned frequently enough. At the Swiss National Forest Inventory, the WSL is responsible for planning, data collection, analysis and scientific interpretation; the FOEN is responsible for forest policy interpretation.

Learn from the summer drought

According to the latest climate scenarios for Switzerland, we are likely to experience very hot and dry summers like in 2018 on a more regular basis in the future. During the dry phase, the WSL started targeted investigations into the effect of the drought. Whereas the leaves already started to change colour in summer in many places, in the following years the crowns of some beech trees died and there was twice as much damage caused to spruces by bark beetles. The researchers developed a synthesis to benefit forestry practice: the combined occurrence of drought, storms, diseases and pests will fundamentally change our landscapes, so we need to learn from extreme events today and adapt forest management to suit future conditions.

The quantity of dead wood has increased, but the target quantities have not yet been reached everywhere.
› Urs-Beat Brändli/WSL

Collecting leaf samples in the crown of a beech tree
› Marco Walser/WSL


Empa
"WE ARE MODELLING
THE ENERGY CITY
OF THE FUTURE."

Buildings, districts and cities currently often have outdated energy systems. Homes must be made more energy-efficient and districts need to be supplied with renewable energy. In cities, the aim is to turn energy production and mobility into sustainable systems. This involves complex energy models that Kristina Orehounig is researching in her "Urban Energy Systems" department at Empa.

From small to large. From complicated to complex. From architecture to construction physics. Kristina Orehounig has taken this scientific path. She studied architecture at the Technical University of Vienna, received a doctorate in building simulation and has now been in charge of the "Urban Energy Systems" department at Empa for two years: energy systems of buildings, districts and even entire cities are being researched here based on an interdisciplinary and networked approach which is geared toward a sustainable future.

Ms Orehounig, buildings are the smallest units in urban energy systems. What is the biggest energy challenge in this context? Individual buildings in Switzerland are mostly already built and consume quite a lot of energy relatively speaking. Depending on the type of building and its location, we need to renovate them to make them more energy-efficient, for example by installing façade insulation, replacing windows and insulating roofs, in order to reduce their energy consumption as an initial objective.

And then? We need to integrate more energy-efficient equipment and replace heating systems fired by fossil fuels like oil and gas with systems based on renewable energy: photovoltaics to generate electricity, heat pumps, solar thermal energy, combined heat and power or district heating for heating. The aim is to stop using fossil fuels in the building and to use little or no more energy.

No energy? The right balance must be found. There are always periods of energy consumption. This can be produced ad hoc by a solar system on the roof. Or the energy required in winter is generated in summer and then stored.

Has storage technology been fully developed? Short-term storage is not a problem. Long-term storage technologies have already been developed but are rarely integrated. This is also because there are no financial incentives as the electricity market is not open. Optimal energy management requires knowledge of the microclimate of buildings or clusters of buildings in urban areas. The step up from supplying a house to an entire district increases the complexity of the models and these become a big data project: a wealth of data from weather stations or temperatures or shading of houses must be prepared so that the energy consumption of residential units and the ideal energy mix in a district can be calculated.

Ms Orehounig, what concrete findings did you make based on the models you have calculated? We design the optimal energy system for a district and calculate how many heat pumps or photovoltaic cells we need to integrate, and whether storage technology or a heating network is required. We design a layout for optimal operation and show how the energy must flow. This minimises costs and CO_2 emissions.

Is this the best way to create the energy-efficient city of tomorrow as a sustainable ecological space? We can now map urban districts with our models. In an entire city, the complexity is higher. We cannot map every building in detail, so simplifications are required. The future must also be included in the models, for example the effects of climate change. In this way, cooling rather than heating may become an issue. Just like urban mobility, which cannot be based on fossil fuels but rather only electric forms of transport. And alternative energy will be produced more locally, i.e. decentralised. In the future, all this must be optimally interconnected in urban areas.

The research teams reporting directly to the head of the department have worked closely with energy suppliers, cities and communes to develop their models. The resulting software is now so sophisticated that any number of urban districts can be viewed and evaluated in terms of energy efficiency. The data pool is now being continuously expanded, so that researchers can draw on empirical values for comparable urban areas where concrete measurement data is lacking.

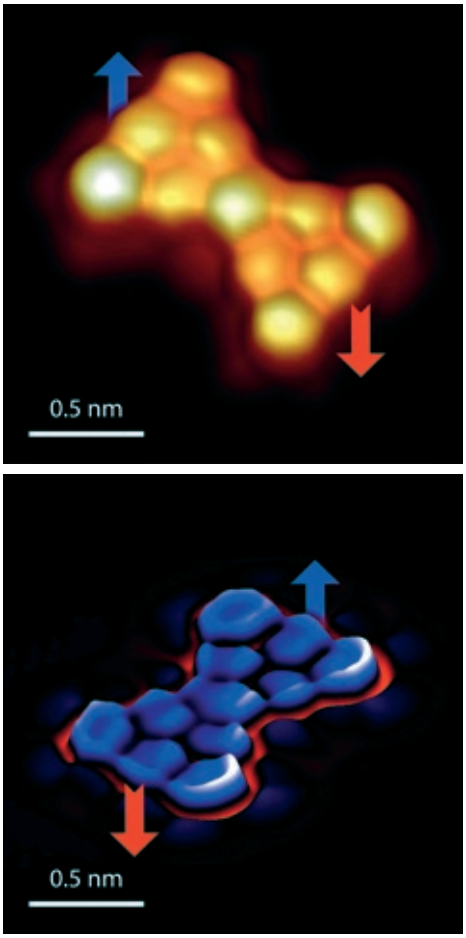
Ms Orehounig, your research should be put into practice on a large scale. How are things progressing where this is concerned? That is also happening. Within our department, some researchers joined forces to establish the start-up "Sympheny" as an Empa spin-off. They want to further develop and commercialise our platform into an easy-to-use app. The aim is to provide energy planners with sustainable and low-cost solutions for supplying energy to suburbs, districts, specific sites, villages or even cities.

"The aim is to eliminate fossil energy sources and to use little or no more energy there."

"In the city of the future, decentralised, alternative energy production and energy consumption in buildings as well as electromobility must be optimally integrated into a single urban system."

› Kristina Orehounig, Head of the Laboratory of Urban Energy Systems at Empa

On the way to spin computers



Above: Scanning tunnel microscopy image of a graphene "nano-fly" with magnetic moment (arrows). Below: Molecular model of a graphene "nano-fly" with magnetic moment (arrows).
› Empa

Depending on the shape and orientation of the edges, graphene nanostructures can have different properties, such as electrically conductive, semi-conductive or insulating. However, one characteristic was practically impossible until now: magnetism. Empa researchers, together with international partners, have succeeded in synthesising a magnetic graphene nanostructure, which was already theoretically predicted in the 1970s and has roughly the shape of a tuxedo tie – an important step towards spin-based information processing ("spintronics") which works at room temperature and promises faster computers with lower power consumption.

Revolutinising industries with AI materials

Thanks to acoustic and optical sensors and with the help of artificial intelligence (AI), Empa researchers have been able to demonstrate that the process they have developed is capable of controlling the quality of 3D printed metal parts in real time during the manufacturing process. Defects are immediately detected and rectified directly. Empa researchers also use AI and machine learning to give wood new properties and to control them during the finishing process. Together with Swiss Wood Solutions, a spin-off of Empa and ETH Zurich, they are developing a digital selection and processing procedure as part of an Innosuisse project to produce high-tech hardwood products of consistent quality from native spruce and sycamore timber. At the same time, an Empa team analysed the opportunities and risks associated with AI for our society as part of a TA-SWISS study. This resulted in recommendations for areas such as work, education and research, consumption, media and administration.

High-performance batteries in the future

The demand for battery storage devices is increasing massively. Empa is therefore researching new environmentally friendly and safe battery concepts, such as more powerful and longer-lasting solid-state batteries. For example, they developed a thin-film ceramic that conducts around 100 times better than previous electrolyte materials – and can be manufactured industrially. The SeNSE project, which the EU funds with EUR 10 million and in which 11 partners from 7 countries work together under the leadership of Empa researcher Corsin Battaglia, produces next-generation lithium-ion batteries. Battaglia also represents Switzerland in the BATTERY 2030+ research initiative, the aim of which is to bring Europe to the forefront of global battery development and production. And non-flammable electrolytes developed at Empa are even intended to facilitate the recycling of lithium-ion batteries. In September 2020, the electric vehicle manufacturer Kyburz commissioned a new battery recycling plant which recovers more than 90% of the metals and was designed in collaboration with Empa experts.

EAWAG

EVERYTHING IS INTERCONNECTED – MANY LOSSES ARE IRREVERSIBLE

Biodiversity on Earth is declining dramatically. Eawag has always had a great tradition of supporting research on biodiversity. With modern research approaches and a highly interdisciplinary environment, which is almost the only one of its kind worldwide, it also wants to contribute to ensuring that politics, the economy and society have the necessary foundations to understand and preserve biodiversity.

"At Eawag, biodiversity research is conducted across all aquatic ecosystems and many groups of organisms. In this way, even complex cascade effects can be researched."

› Professor Florian Altermatt, Co-Leader of the Blue-Green Biodiversity Research Initiative

What Florian Altermatt, Professor of Aquatic Ecology at the University of Zurich and Group Leader in the Department of Aquatic Ecology at Eawag, has to report is alarming: "The loss of biodiversity has assumed dramatic proportions," the scientist states, "there has been a 50 to 90% decline in some populations worldwide, especially in aquatic habitats. Around a million species are at risk of extinction." The human-made change in biodiversity on the Blue Planet is now called mass extinction, similar to that of the dinosaurs about 66 million years ago. The extinction of species is irreversible, and the changes in biodiversity are mainly due to changes in land use, climate change, pollution of ecosystems, direct persecution of populations or even invasive species. "Scientists have been aware of all of the above for decades," said Professor Altermatt, "humanity presumably only has a small window of two to three decades to reverse this development."

The human-made change in biodiversity on the Blue Planet is now called mass extinction, similar to that of the dinosaurs.

Since the 1980s, scientific biodiversity research has intensified and, over time, also turned to more socially relevant issues. Originally, this came from taxonomic research, in which biodiversity was classified according to certain criteria, and from ecology, in which the functional significance of biodiversity or also interactions of species were scientifically investigated. At the same time, it became increasingly apparent that biodiversity and species composition are negatively affected by human-made environmental changes. All of the above led to the United Nations Convention on Biodiversity at the Rio Earth Summit in 1992. "This was a formative moment that brought the issue of biodiversity to the attention of people outside the scientific community," said Professor Altermatt.

Eawag covers a wide range of scales in biodiversity research in various areas. In this way, pivotal, fundamental questions can be researched: How does biodiversity occur? How can it be preserved? How does biodiversity affect ecological processes? This occurs, for example, at the level of bacteria in waste water treatment plants. Or at the level of natural ecosystems: How does a change in the algae communities in lakes affect the biodiversity of invertebrates or fish? "At Eawag, biodiversity research is covered across the whole range of aquatic ecosystems," is how Professor Altermatt sums it up. In this way, complex trophic cascade effects can be researched which arise when food chains change at different levels. The entire interdisciplinary research community at Eawag is often involved in this across the most varied of disciplines, ranging from the engineer to the social scientist and field ecologist. The research approach usually adopted at the institution is now similarly sophisticated. The same issues are theoretically studied and mathematically modelled, investigated in parallel using experiments under controlled conditions in the laboratory and researched in small model ecosystems, before later being transferred to the entire landscape. Basically, this is the formula for reducing complexity and getting application-oriented results.

The latest strategic Blue-Green Biodiversity Research Initiative (BGB) for interdisciplinary research on "blue-green", aquatic and terrestrial biodiversity, which is supported together with the WSL, is also to be seen in this context. In the autumn of 2017, the Federal Council adopted an action plan on the biodiversity strategy, the aim of which is to develop biodiversity through ecological infrastructure and species conservation, among other things. The ETH Board has now taken the ball and is running with it by supporting the BGB initiative, which is planned for five years until 2024, with CHF 6.5m. Under the co-leadership of Eawag researcher Altermatt and WSL scientist Catherine Graham, Group Leader in Spatial Evolutionary Ecology and Associate Professor of Ecology and Evolution at Stony Brook University (USA), synergies are created, in order to strengthen the internationally recognised environmental research of the two research institutions with the aim of researching biodiversity at the interface of aquatic and terrestrial ecosystems.

Networks instead of phylogenetic trees

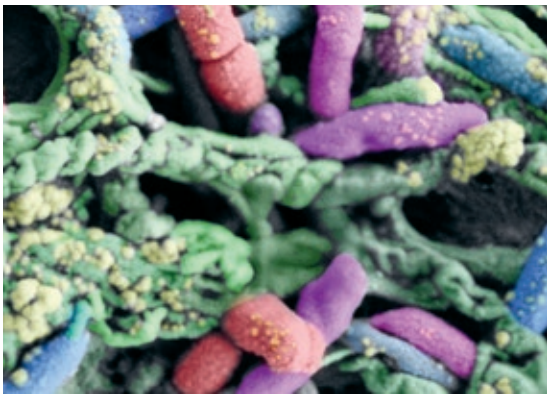
In a new "Nature" study, a team from Eawag and the University of Bern describes striking differences in the rate and frequency of speciation of otherwise similar fish. The researchers explain the super-frequent and explosive speciation with a model that describes the evolution of species not as a phylogenetic tree, but as a genetic network in which species repeatedly exchange genetic material. Under favourable ecological conditions, the exchange of genetic variants dramatically accelerates the formation of new species. "Indels" – short, hitherto neglected "optional" DNA sequences – play an important role here. The study is based on genome analyses of 100 species of cichlid from Lake Victoria and comparisons with more than 1,600 relatives worldwide.

LeCo project: Legionella control in buildings

In response to the growing number of cases of legionnaires' disease in Switzerland, the Federal Food Safety and Veterinary Office (FSVO) launched the research project LeCo (Legionella control in buildings) in early 2020, in partnership with the Federal Offices of Public Health (FOPH) and Energy (SFOE). Over the next four years, a multidisciplinary team under the auspices of Eawag will be investigating how the risk of shower-related legionella infection can be assessed. In addition, an improved sampling strategy is to be developed and the use of rapid detection methods to correctly identify contamination in buildings is to be optimised. Other aims are to explore the relationship between environmental infection sources and cases of disease, and to gain new insights into the ecology of legionella in drinking water systems. Ultimately, management strategies are to be developed to reduce the risk of legionella contamination in buildings. But alongside the research aspects, the project will also be focusing on awareness-raising and increased communication among the various actors concerned. In addition, national and international cooperation is to be strengthened in this field.

Planning aid for granulated activated carbon filters

Swiss sewage treatment plants are currently being upgraded with an additional stage for the elimination of organic trace substances. The so-called Micropoll strategy was developed by the Swiss Confederation. The association of Swiss wastewater and water protection experts (VSA) also operates the micropollutants process technology platform. Numerous basic principles of the strategy and procedures were researched at Eawag. So far, ozonation (e.g. in the Dübendorf waste water treatment plant) and filters containing granulated activated carbon (GAC) are being used (e.g. in the ARA Altenrhein waste water treatment plant). GAC filters are referred to by experts as being an interesting technology, but there are still uncertainties and open questions about various aspects like the dimensioning of the plants. In December 2019, Eawag and the VSA therefore conducted a workshop on the elimination of trace substances using GAC filtration. In addition to research representatives, ARA operators, engineering offices and specialists from the FOEN and the VSA also participated. A broad consensus paper has now emerged from the workshop providing certainty where the planning and operation of systems for eliminating trace substances with GAC filters at Swiss waste water treatment plants is concerned. As co-organiser Marc Böhler from Eawag points out, colleagues from Germany were also consulted. Eawag and VSA are thus making an important contribution to supporting the practical implementation of the process of eliminating trace substances.



An electron microscope image of bacterial communities in a shower hose.
› Frederik Hammes, ZMB, UZH

Pilot tests on GAC filtration at the ARA in Muri.
› Eawag

GOVERNANCE

Structure and leadership of the ETH Domain

The Federal Government operates the Federal Institutes of Technology in accordance with the Federal Constitution (Art. 63*a* Para. 1). As this is the law governing the ETH Domain, the ETH Act defines this mission. Together with Art. 64 Para. 3 of the Federal Constitution, it also forms the legal foundation for operating the four research institutes of the ETH Domain.

The ETH Domain: legal basis
The Federal Act on the Federal Institutes of Technology of 4 October 1991 (ETH Act) defines the status, structure and mission of the ETH Domain. The ETH Domain is autonomous within the framework of the law and it is affiliated to the responsible government department pursuant to the ETH Act. This has been the Federal Department of Economic Affairs, Education and Research (EAER) since the beginning of 2013. The ETH Act defines the autonomy of the two Federal Institutes of Technology and the four research institutes. The ETH Board is the strategic governing and supervisory body of the ETH Domain.

In November 2019, the Federal Council transferred to the Parliament a draft bill for the partial revision of the ETH Act with a corresponding dispatch. The new regulations up for discussion would in particular affect the implementation of recommendations of the Swiss Federal Audit Office (SFAO) regarding the general oversight competencies of the ETH Board and two corporate governance guidelines (restriction of voting rights and absence of institutional members of the ETH Board). Further adaptations include various personnel policy changes (in particular for employment after retirement and for the renewal of fixed-term employment contracts), the creation of a legal basis for the sale of surplus energy purchased or generated for the institution's own use, for disciplinary measures, as well as for security services and video surveillance. During the 2020 summer session, the National Council deliberated on the bill for the first time, and the Council of States did so during the 2020 autumn session. The amendments to the Act are expected to come into force during the course of 2021.

Tasks and leadership
According to the purpose set out in Art. 2 ETH Act, both Federal Institutes of Technology and the four research institutes (institutions of the ETH Domain) must educate students and specialists in scientific and technical fields and ensure continuing education, expand scientific knowledge through research, foster the development of junior scientific staff, provide scientific and technical services, perform public relations work, and make use of their research results.

The institutions of the ETH Domain discharge their mission in observance of internationally recognised standards. They take account of Switzerland's needs and promote international cooperation.

Strategic objectives and expenditure ceiling
The political leadership of the ETH Domain rests with the Federal Council and the Federal Parliament. The central leadership tools are the Dispatch on the Promotion of Education, Research and Innovation (ERI Dispatch) and the associated strategic objectives set by the Federal Council for the ETH Domain. The political tools are supplemented by the ETH Board's strategic controlling, which provides information on financial reporting and mission fulfilment.

Reporting
The ETH Board reports annually to the Federal Council and shows the degree to which the strategic objectives have been met and how the ETH Domain has used the annual federal funding contribution. Based on the ETH Board's report, the Federal Council informs Parliament with a report. In each half of the Promotion of Education, Research and Innovation Policy (ERI) period, the ETH Board compiles a self-evaluation report which comments on issues specified by the competent Federal Councillor, including on reaching the strategic objectives. This self-evaluation report serves as the basis for the evaluation of the ETH Domain by a group of international experts (peer review) which is to be carried out by the Federal Department of Economic Affairs, Education and Research (EAER).

In the context of the application for funding for the next ERI period, the EAER informs Parliament about the status of the achievement of goals in an interim report (Art. 34*a* ETH Act). The ETH Board is responsible for the strategic leadership of the ETH Domain (see next section). The Executive Boards of both Federal

Institutes and the Directorates of the four research institutes are responsible for the operational leadership of the individual institutions of the ETH Domain. In accordance with Art. 4 Para. 3 ETH Act, the institutions of the ETH Domain assume all responsibilities which are not expressly assigned to the ETH Board by the ETH Act.

ETH Board: Mission and operating principles

The ETH Board defines the strategy of the ETH Domain within the framework of the strategic objectives of the Federal Council, represents the ETH Domain when dealing with policy-makers and government authorities at federal level, issues directives about financial controlling, and carries out strategic controlling. It also approves the development plans of the institutions of the ETH Domain, oversees their implementation and supervises the ETH Domain (Art. 25 ETH Act). It agrees targets with the institutions and allocates federal funds, specifically on the basis of the institutions' budget requests (Art. 33*a* ETH Act). It submits requests to the Federal Council for the election or re-election of the Presidents of the two Federal Institutes of Technology and of the Directors of the four research institutes (Art. 28 Para. 1 and 7 ETH Act). It also appoints the other members of the Executive Boards of the two Federal Institutes of Technology and of the Directorates of the four research institutes (Art. 28 Para. 4 and 7 ETH Act). Finally, the ETH Board appoints professors at the request of the Presidents of both Federal Institutes of Technology (Art. 14 Para. 2 and 3 ETH Act).

The ETH Board performs its supervisory function through the use of the following tools: periodic reporting by the institutions on resources (finances, personnel, real estate), annual reporting by the institutions on the extent to which they have fulfilled their duties with regard to target agreements, annual discussions (known as dialogues) between the ETH Board and the institutions of the ETH Domain within the scope of strategic controlling, handling supervisory complaints addressed to it while observing subsidiarity and institutional autonomy, as well as reports by the institutions within the scope of their risk management systems. Moreover, the ETH Board's Internal Audit evaluates the risk management processes, internal control system (ICS) and governance processes of the institutions and report on them to the ETH Board.

The rules of procedure of the ETH Board are published in the compilation of Federal law. The ETH Board usually meets five times a year for two days at a time, and arranges additional meeting days for dialogues with the institutions of the ETH Domain. The President of the ETH Board is responsible for holding periodic individual discussions with the Presidents of the two Federal Institutes of Technology and with the Directors of the research institutes.

Discussions are held twice a year between the proprietor, represented by the EAER and the Federal Department of Finance (FDF), and the ETH Board, represented by its President.

Structure of the ETH Domain

* employment contracts including doctoral students, as of: 31 December 2020

ETH Domain

ETH Board
11 members
56 employees (staff, Internal Audit, Internal Appeals Commission)

Federal Institutes of Technology

ETH Zurich
23,422 students and doctoral students
12,855 employees*

EPFL
11,813 students and doctoral students
6,358 employees*

Research institutions

PSI
2,097
employees*

WSL
564
employees*

Empa
1,022
employees*

Eawag
522
employees*

Audit and Executive Committees

The Audit Committee assists the ETH Board in financial supervision and in the monitoring of risk management, of the ICS and of financial auditing activities. As a rule, it is composed of two to three "external" ETH Board members who are independent of the executive leadership, but may also involve additional people in a consultative capacity. The President of the ETH Board, the head of the Internal Audit department and the head of the Finance section of the ETH Board's staff attend the meetings in an advisory capacity.

The Executive Committee assists the ETH Board in preparing for and following up on meetings, in filling management positions of institutions in the ETH Domain and in fulfilling its duties as an employer. It also liaises with the social partners. It is composed of the President of the ETH Board (chair), the Presidents of both Federal Institutes of Technology, the representative of the research institutes and the delegates of the University Assemblies. The Executive Director and, if necessary, other members of the ETH Board's staff attend the meetings.

Remuneration of the ETH Board

In January 2020, the Acting President of the ETH Board received a gross salary of CHF 15,265 (0.5 FTE with an annual salary of CHF 366,366 for 1.0 FTE). In addition, the employer paid social security contributions of CHF 961. From February to December 2020 the new President of the ETH Board received a gross salary of CHF 268,668 (0.8 FTE with an annual salary of CHF 366,366 for 1.0 FTE). In addition, the employer paid social security contributions of CHF 73,954. The new President is insured by the Swiss Federal Pension Fund, the rules of which determine the employer's contributions.

The two Vice Presidents (Acting and former), who are not in an employment relationship with an institution of the ETH Domain, received a lump sum to a total of CHF 26,000 in 2020 for January and the period from February to December (pro rata). In 2020, the other four external members of the ETH Board each received a lump sum of CHF 20,000. In addition, they were paid a total of CHF 54,400 for dialogue meetings, the Election Preparation Committee and Audit Committee meetings (incl. pro rata lump sums amounting to a total of CHF 6,000 for chairing the Audit Committee for the corresponding audit of the annual financial statements). In addition, their expenses were refunded on the basis of the ETH Board Ordinance of 11 April 2002 concerning the reimbursement of expenses in the ETH Domain.

Those "institutional" members of the ETH Board who are employees of one of the institutions of the ETH Domain do not receive additional fees for their activities on the ETH Board. For the 0.7 FTE position, the ETH Board covered 40% of the wage and social security costs (including compensation for expenses) incurred by EPFL for the delegates of the University Assemblies of both Federal Institutes of Technology, in order to guarantee the delegates' independence from either institution.

Monitoring and auditing

Internal control system
The institutions of the ETH Domain each have an ICS (Art. 35*a*[bis] ETH Act). It was introduced using the template provided by the Federal Government. Its objectives are to protect the assets of the ETH Domain, to prevent errors and irregularities in accounting, and to ensure proper accounting and reliable reporting. It is an integral part of the audit by the Swiss Federal Audit Office (SFAO) or the auditors appointed by it. The focus is on financially relevant business processes.

Internal audit
The Internal Audit department conducts internal audits for the institutions of the ETH Domain (Art. 35*a*[ter] Para. 1 ETH Act and Art. 11 of the Federal Audit Office Act). This department reports directly to the President of the ETH Board and its activities are supervised by the Audit Committee. The Internal Audit department provides independent, objective auditing services and supports the ETH Domain in achieving its aims. It is also responsible for coordinating and supporting the external audits of the ETH Domain.

Auditors
The SFAO performs external auditing duties for the ETH Domain (Art. 35*a*[ter] Para. 3 ETH Act). In 2020, it audited the consolidated financial statements of both Federal Institutes of Technology, the consolidated financial statements of the ETH Domain and it conducted interim audits. The SFAO performs the audits of the research institutes jointly with PricewaterhouseCoopers (PwC). The SFAO's audit report on the consolidated financial statements of the ETH Domain comprises an audit report and a so-called "comprehensive report". These reports are discussed with representatives of the SFAO in the Audit Committee every year. In 2020, the SFAO invoiced the ETH Board for the total amount of CHF 538,576 (CHF 326,793 for the 2019 annual review and CHF 211,783 for the interim audit of the 2020 annual financial statements).

Information policy
Its statutory role makes the ETH Board an interface between academia, policy-makers and society. Within its rules of procedure, the ETH Board undertakes to ensure honest, appropriate and transparent communication for the benefit of society and aims to explain its decisions and reinforce the role and reputation of the ETH Domain. Responsibility for this rests with the President. The key communication tools are the ETH Board's annual report to the Federal Government, the website www.ethboard.ch, targeted media relations work and the case-by-case illumination of relevant facts and positions, particularly regarding policies on education, research and innovation.

Participations and cooperations

In accordance with Article 3*a* ETH Act, the two Federal Institutes of Technology and the four research institutes may found or invest in companies, or cooperate with third parties in any other way within the framework of the strategic objectives and the ETH Board's directives, for the purpose of fulfilling their duties. The investments and relationships with controlled and associated entities are listed in sections 20 and 35 of the annual financial statements in the ETH Board's Annual Report and Financial Report respectively. These mainly involve investments in foundations and simple partnerships which meet accounting standards. The controlled entities Société du Quartier d'Innovation (SQIE) and Société du Quartier Nord de l'EPFL (SQNE), which maintain buildings on a finance lease basis with contracts over a lease term of 30 years, generate cash outflows thereof of about CHF 9m per annum. The associated entities' have significant investments in the ETH Zurich Foundation. The contribution to the annual result of the ETH Domain amounted to CHF 32m.

Management bodies of the ETH Domain

Presidency and Members of the ETH Board
- Prof. Dr Michael O. Hengartner[1], President (since February 2020)
- Beth Krasna[1], Acting President (until the end of January 2020), Vice President (from February to December 2020)
- Prof. Dr Dr h. c. Barbara Haering[2], President of the Audit Committee (since May 2019), Vice President (since January 2021)
- Prof. Dr Joël Mesot[1]
- Prof. Dr Martin Vetterli[1]
- Prof. Dr Gian-Luca Bona[1]
- Dr Kristin Becker van Slooten[1]
- Marc Bürki[2]
- Beatrice Fasana
- Prof. Dr sc. nat., Dr h. c. mult. Susan Gasser
- Christiane Leister
- Cornelia Ritz Bossicard[2] (since January 2021)

Executive Board of ETH Zurich
- Prof. Dr Joël Mesot, President
- Prof. Dr Sarah Springman, Rector
- Prof. Dr Detlef Günther, Vice President for Research
- Dr Robert Perich, Vice President for Finance and Controlling
- Prof. Dr Vanessa Wood, Vice President for Knowledge Transfer and Corporate Relations (since January 2021)
- Prof. Dr Ulrich Weidmann, Vice President for Infrastructure
- Dr Julia Dannath-Schuh Vice President for Personnel Development and Leadership (since November 2020)

Executive Board of EPFL[3]
- Prof. Dr Martin Vetterli, President
- Prof. Dr Pierre Vandergheynst, Vice President for Teaching (until the end of 2020)
- Prof. Dr Andreas Mortensen, Vice President for Research (until the end of 2020)
- Prof. Dr Marc Gruber, Vice President for Innovation (until the end of February 2021)
- Caroline Kuyper, Vice President for Finance (until the end of 2020)
- Dr Etienne Marclay, Vice President for Personnel and Operations (until the end of July 2020)
- Dr Matthias Gäumann, Vice President for Operations (since August 2020)
- Prof. Dr Edouard Bugnion, Vice President for Information Systems (until the end of 2020)

January 2021: New on the EPFL Management Board
- Prof. Dr Gisou van der Goot, Vice President for Responsible Transformation
- Prof. Dr Jan Hesthaven, Vice President for Academic Affairs
- Dr Ursula Oesterle, Vice President for Innovation (since March 2021)
- Marc Bachelot, Acting Vice President for Finances

Directorate of the PSI
- Prof. Dr Christian Rüegg, Director (since April 2020)
- Prof. Dr Gabriel Aeppli, Deputy Director (since September 2020)
- Dr Thierry Strässle, Deputy Director (since September 2020)
- Dr Peter Allenspach, Member
- Prof. Dr Andreas Pautz, Member
- Prof. Dr Gebhard F. X. Schertler, Member

Directorate of WSL
- Prof. Dr Konrad Steffen[4], Director (until August 2020)
- Dr Christoph Hegg[4], Deputy Director and Acting Director (since August 2020)
- Prof. Dr Anna Hersperger, Member
- Prof. Dr Rolf Holderegger, Member and Acting Deputy Director (since August 2020)
- Prof. Dr Andreas Rigling, Member
- Prof. Dr Jürg Schweizer, Member
- Prof. Dr Niklaus Zimmermann, Member (until the end of July 2020)

Directorate of Empa
- Prof. Dr Gian-Luca Bona, Director
- Dr Peter Richner, Deputy Director
- Dr Brigitte Buchmann, Member
- Dr Alex Dommann, Member
- Dr Pierangelo Gröning, Member
- Dr Urs Leemann, Member
- Dr Tanja Zimmermann, Member

Directorate of Eawag
- Prof. Dr Janet Hering, Director
- Prof. Dr Rik Eggen, Deputy Director
- Prof. Dr Jukka Jokela, Member
- Prof. Dr Tove Larsen, Member
- Gabriele Mayer, Member
- Prof. Dr Alfred Johny Wüest, Member
- Prof. Dr Christian Zurbrügg, Member
- Prof. Dr. Carsten Schubert, Member (from April 2021)

Appeals body

ETH Internal Appeals Commission
The ETH Internal Appeals Commission decides on appeals against rulings made by bodies of the institutions of the ETH Domain (Art. 37 Para. 3 ETH Act). It is an independent internal appeals body with its registered office in Bern and is administratively assigned to the ETH Board, to which it reports (Art. 37*a* ETH Act). Appeals mainly relate to matters arising from legislation on human resources and higher education. Appeals against the rulings of the ETH Internal Appeals Commission can be made to the Federal Administrative Court.

- Lawyer Barbara Gmür Wenger, President (since January 2020)
- Dr iur. Beatrix Schibli, Vice President (since January 2020)
- Prof. Dr Simone Deparis, Member (since January 2020)
- Jonas Philippe, Member
- Dr Dieter Ramseier, Member
- Prof. Thomas Vogel, Member (since January 2020)
- Yolanda Schärli, Member

ETH Board support

Staff of the ETH Board
The ETH Board's staff support the ETH Board in fulfilling its legal mandate, particularly regarding strategic leadership, supervision, promotion of cooperation in the ETH Domain and liaising with the Federal authorities (Art. 26*b* ETH Act).

Executive Team
- Dr Michael Käppeli, Executive Director
- Dr Kurt Baltensperger, Head of Science
- Gian-Andri Casutt, Head of Communications
- Dr Dieter Künzli, Head of Finance and Personnel
- Dr Monique Weber-Mandrin, Head of Legal Services
- Michael Quetting, Head of Real Estate
- Barbara Schär, Head of ETH Board Secretarial Office (until the end of 2020)

Internal audit
The ETH Board employs Internal Audit staff, as per Art. 35*a*[ter] ETH Act.
It conducts the internal audits of the institutions of the ETH Domain.
- Patrick Graber, Head

[1] Member of the Executive Committee
[2] Member of the Audit Committee
[3] For the second term of office of its President Martin Vetterli, EPFL is making a structural change to the Executive Board.
[4] The Director of the WSL had a fatal accident on 8 August 2020 and Dr Christoph Hegg is serving as Acting Director of the WSL until a new Director can be found.

Beth Krasna left the ETH Board at the end of December 2020. Cornelia Ritz Bossicard became a new member of the ETH Board in January 2021 (see p. 45).

Status as at 31 December 2020 (reference is also made to changes agreed in 2020 which will become effective in 2021)

Ombuds Office

Ombuds Office
The Ombuds Office of the ETH Board (nyffenegger@mgnrecht.ch) is an independent body responsible in a subsidiary capacity for dealing with reports of illegal and unethical conduct observed by members of the ETH Domain in the course of ETH Domain-related activity. Subsidiary capacity means that, whenever possible, reports must initially be made inside the two Federal Institutes of Technology or the four research institutes, first to senior bodies or, if this is deemed unreasonable, to the bodies responsible for dealing with such reports in the institutions concerned.

This applies without prejudice to Art. 22*a* of the Federal Personnel Act (FPA): the employees are obliged to report all officially prosecutable crimes or offences which they have discovered during their official work or which have been reported to them, to the criminal prosecution authorities, their superiors or the Swiss Federal Audit Office (SFAO).

The ombudsman is:
– Dr Res Nyffenegger, external lawyer in Bern

Conciliation Commission

Conciliation Commission under the Gender Equality Act for the ETH Domain
The Conciliation Commission under the Gender Equality Act for the ETH Domain provides information and Otionships in the ETH Domain. The aim of the conciliation process is to achieve a mutually acceptable solution to the dispute in verbal negotiations with the parties (employer and employee) in order to avoid court proceedings. The Conciliation Commission does not issue any judgments. It handles cases confidentially, but not anonymously.

President's Office:
– Dr Anne-Catherine Hahn, President

Employer representative:
– Andreas Kirstein, ETH Zurich (member)
– Hélène Fueger, EPFL (member)
– Natalie Lerch-Pieper, PSI/Eawag (substitute member)
– David Heusser, Empa/WSL (substitute member)

Employee representative:
– Gregor Spuhler, ETH Zurich (member)
– Sabine Süsstrunk, EPFL (member)
– Rowena Crockett, Empa/WSL (substitute member)
– Dario Marty, PSI/Eawag (substitute member)

Professorial matters

Appointment of professors
In 2020, the ETH Board dealt with 174 professorial matters. It appointed a total of 76 professors, 48 of whom were newly appointed members of staff and 28 were internal promotions. At ETH Zurich 19 women and 32 men were appointed, and 5 women and 19 men were appointed at EPFL. In addition, a scientist, the new director of the PSI, was appointed a full professor at both ETH Zurich and EPFL.

Out of the 28 full professor appointments, 15 were promotions of associate professors, and 13 of the 22 associate professor appointments were promotions of assistant professors with tenure track.

Women accounted for 19 (39.6%) of the 48 newly appointed professors.

In 2020, the ETH Board appointed a male affiliated professor at ETH Zurich. Affiliated professors mainly work at a research institution in Switzerland or abroad and are employed at one of the two Federal Institutes of Technology on a reduced employment level. They have the status of a full professor and count as such in the statistics.

In addition, the ETH Board awarded the title of professor (adjunct professor) to 2 female and 9 male scientists.

Retirements and resignations
In 2020, the ETH Board was informed of 31 retirements: 18 from ETH Zurich and 13 from EPFL. In addition, ETH Zurich and EPFL advised the ETH Board of a total of 7 resignations for other reasons.

Appointments

76

professors, 19 of whom were women and 32 men at ETH Zurich, as well as 5 women and 19 men at EPFL and 1 man at both ETH Zurich and EPFL

Proportion of women

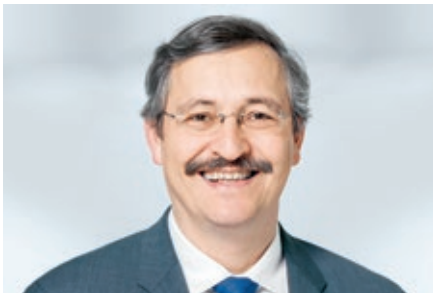
39.6 %

of newly appointed persons

The total of 76 appointments comprised:

Full professorships *	Associate professorships	Assistant professorships with tenure track	Assistant professorships without tenure track
28	22	14	12
9 of whom were women	5 of whom were women	5 of whom were women	5 of whom were women

* 1 of whom was a male affiliated professor



Michael O. Hengartner
* 1967, Swiss/Canadian
Prof. Dr

President of the ETH Board since February 2020.

Michael O. Hengartner served as President of the University of Zurich (UZH) from February 2014 to January 2020. From 2016 until his resignation as President of the UZH, he also served as President of swissuniversities. M.O. Hengartner has dual Swiss and Canadian citizenship. He grew up in Quebec City where he studied biochemistry at the Université Laval. In 1994, he was awarded his doctorate at the Massachusetts Institute of Technology in the laboratory of Nobel Laureate H. Robert Horvitz. After that, he headed a research group at the Cold Spring Harbor Laboratory in the USA until 2001. In 2001, he was appointed to the newly established Ernst Hadorn Endowed Professorship at the Institute of Molecular Biology at the UZH. From 2009 to 2014, he was Dean of the Faculty of Science of the UZH.

Beth Krasna
* 1953, Swiss/US citizen
Dipl. Ing.

Member of the ETH Board since 2003 and President of its Audit Committee from 2008 until April 2019. Since 2018 Vice President and from May 2019 until the end of January 2020 Acting President of the ETH Board. Independent board member.

Beth Krasna has a degree in chemical engineering from ETH Zurich and a Master's degree in management from the Massachusetts Institute of Technology (Cambridge, USA). She is a member of the Board of Directors of Symbiotics SA as well as President of the Board of Directors of Ethos Services SA and of Xsensio SA. Additionally, B. Krasna is Vice President of the Foundation Board of the Graduate Institute of International and Development Studies in Geneva, and a member of the Swiss Academy of Engineering Sciences.

Barbara Haering
* 1953, Swiss/Canadian
Prof. Dr sc. nat., Dr h. c. sc. pol.

Member of the ETH Board and of the Audit Committee since 2008, and President of the Audit Committee since May 2019. From May 2019 to the end of January 2020 Acting Vice President and since January 2021 Vice President of the ETH Board. Member of the Executive Board of econcept AG.

Barbara Haering studied natural sciences and obtained a doctorate in spatial planning at ETH Zurich in 1996. She is a member of the Executive Board of econcept AG. In addition, she chairs the Conseil d'orientation stratégique at the University of Geneva and the Council of Foundation of the Geneva International Centre for Humanitarian Demining. Moreover, B. Haering is a member of the University Council of Dresden University of Technology and member of the Research and Technology Advisory Committee at Graz University of Technology. She is a lecturer at the University of Lausanne.

Kristin Becker van Slooten
* 1962, Swiss/German
Dr

Member of the ETH Board and of the Executive Committee since 2017. Representative of the university assemblies of ETH Zurich/EPFL on the ETH Board. Project head of equal opportunities at EPFL since 2017. Maître d' enseignement et de recherche (MER).

The environmental scientist Kristin Becker van Slooten studied Biology at the University of Geneva and obtained her doctorate in Environmental Chemistry and Ecotoxicology at EPFL. From 1995 to 2002, she was employed as a scientist at the Laboratory for Environmental Chemistry and Ecotoxicology, where she headed up the Experimental Ecotoxicology research group from 2002, obtaining the title of MER in 2005. From 2006 to 2016, she was an advisor to the President and General Secretary of EPFL. K. Becker van Slooten has been the project manager for equal opportunities at EPFL since 2017 and has reprised her role as a delegate on the ETH Board, representing the university assemblies of ETH Zurich and of EPFL as she did from 2004 to 2006.

Marc Bürki
* 1961, Swiss
Dipl. El.-Ing.

Member of the ETH Board since 2017 and of the Audit Committee since 2018. CEO of Swissquote Group Holding Ltd since 1999 and of Swissquote Bank Ltd since 2002.

Marc Bürki obtained a degree in Electrical Engineering from EPFL. After gaining his initial professional experience with the European Space Agency in the Netherlands, he formed Marvel Communications S.A. in Gland in 1990, a company that specialised in the development of financial information software. Swissquote Group Holding Ltd, which specialises in online trading, was formed in 1999 and was floated on the stock market in 2000. In 2001, Swissquote Bank Ltd received a banking licence. M. Bürki is the CEO of both companies.
› Swissquote

Beatrice Fasana
* 1969, Swiss
Dipl. Ing. Lm

Member of the ETH Board since 2012.
Managing Director at Sandro Vanini SA since 2013.

Beatrice Fasana studied Food Science at ETH Zurich. After a traineeship at the "Nestlé Research and Development Center" in New Milford (Connecticut, USA), she worked in various leadership roles for several large food and beverage production companies in Switzerland, including manager of Chocolat Frey's "Chewing Gum" Profit Center and as a marketing manager for Coca-Cola. Until the end of 2012, she ran her own company BeFood Consulting SA. Since 2013 she has held the position of Managing Director at Sandro Vanini SA, a company of the Haecky Group. B. Fasana is also a member of the Board and Chair of the Management Committee of the University of Applied Sciences and Arts of Southern Switzerland (SUPSI, Scuola universitaria professionale della Svizzera italiana) and has been a member of the Board of Directors of Raiffeisen Bank del Basso Mendrisiotto since 2018.

Joël Mesot
* 1964, Swiss
Prof. Dr sc. nat.

Member of the ETH Board and of the Executive Committee since 2010. President of ETH Zurich since 2019.

Joël Mesot studied physics at ETH Zurich, obtaining a doctorate in solid-state physics in 1992. He was awarded the ETH Zurich Latsis Prize in 2002 and the Swiss Physical Society (SPG) IBM Prize in 1995. After research residencies in France and the USA, he came to ETH Zurich and joined the PSI, where he became Head of the Laboratory for Neutron Scattering in 2004. He was director of the PSI from 2008 to 2018, and he has been a full professor of physics at ETH Zurich since 2008. Professor Mesot is part of various national and international advisory bodies, including the Foundation Board of the "Switzerland Innovation" Park, the Marcel Benoist Foundation, the Global Network Advisory Board of the World Economic Forum (WEF) and the Governing Board CREATE (Singapore).
› Markus Bertschi/ETH Zurich

Martin Vetterli
* 1957, Swiss
Prof. Dr sc.

Member of the ETH Board and of the Executive Committee since 2017. President of EPFL since 2017.

Martin Vetterli received his degree in Electrical Engineering from ETH Zurich, before then completing his Master's in Science at Stanford University and finally obtaining his doctorate at EPFL. Following professorships at Columbia University and at the University of California, Berkeley, he returned to EPFL as full professor of Communication Systems in 1995. From 2000 to 2003, Professor Vetterli was a member of the Swiss Science Council (SSC). From 2004 to 2011, M. Vetterli was Vice President of EPFL, and he was Dean of the School of Computer and Communication Sciences at EPFL from 2011 to 2012. From 2013 until the end of 2016, he was President of the National Research Council of the Swiss National Science Foundation (SNSF).
› Nik Hunger/EPFL

Gian-Luca Bona
* 1957, Swiss
Prof. Dr sc. nat.

Member of the ETH Board since 2019. Representative of the research institutes on the ETH Board. CEO of Empa and dual professor at ETH Zurich/EPFL since 2009.

Gian-Luca Bona studied physics at ETH Zurich, where he completed his doctorate in 1987. He then began his career at IBM, first at the IBM Research Centre in Zurich and later in the USA, where he led the Science & Technology department at the IBM Almaden Research Center in San Jose from 2004 to 2008. He was director of Tape Storage Solutions at IBM in Tucson, from 2008 to 2009, where he was responsible for the research and development of magnetic tape storage products. Professor Bona's roles include being a member of the Foundation Board of the Technopark Zurich and of the Board of Trustees of the Innovation Park Zurich. He is a member of the Board of Directors of Comet Ltd and Bobst Group Ltd, and of the Advisory Council of the Federal Institute for Materials Research and Testing (BAM) in Berlin. He is also a member of the scientific advisory board of CSEM. › Empa

Susan Gasser
* 1955, Swiss
Prof. Dr sc. nat., Dr h. c. mult.

Member of the ETH Board since 2018. Director of the Friedrich Miescher Institute for Biomedical Research from 2004 to 2019. Professor of Molecular Biology at the University of Basel since 2005 and visiting professor at the University of Lausanne since 2021.

Susan Gasser studied biology and biophysics at the University of Chicago and obtained a doctorate at the University of Basel. She was group leader at the Swiss Institute for Experimental Cancer Research (ISREC) at EPFL from 1986 until she was appointed full professor at the University of Geneva in 2001. From November 2004 until March 2019, she was Director of the Friedrich Miescher Institute for Biomedical Research (FMI) in Basel. She has also been a full professor of Molecular Biology at the University of Basel since 2005 and since 2021, she has been a visiting professor at the University of Lausanne. Since February 2021, she has been the Director of the ISREC Foundation and the AGORA Research Centre. Prof. Gasser is the Chair of the scientific advisory board of the health centres of the Helmholtz Association, a member of the scientific advisory board of the Francis Crick Institute in London and a member of the European Molecular Biology Laboratory (EMBL) in Heidelberg. From 2014 to 2019, she chaired the Gender Equality Commission of the Swiss National Science Foundation (SNSF). › Nestlé Nutrition Council

Christiane Leister
* 1955, Swiss/German
Graduate economist (Dipl.-Vw.)

Member of the ETH Board since 2017. Owner and President of the Board of Directors of the Leister Group since 1993.

After graduating from Christian Albrecht University of Kiel with a degree in Economics, Christiane Leister started her career at Jungheinrich (floor-level conveyors and warehousing systems). She then headed the Controlling and Finance departments of Vereinigte Papierwerke AG and Milupa AG. She took over strategic and operational duties within the Leister family business in 1989. She has been the owner of the Leister companies since 1993, where she also acted as operations manager until 2014. During that time, Ch. Leister diversified the companies with new technologies and expanded them internationally to create the Leister Group.
› Leister Ltd

New member of the ETH Board from 2021: Cornelia Ritz Bossicard

On 24 June 2020, the Federal Council appointed Cornelia Ritz Bossicard as a new member of the ETH Board.

Cornelia Ritz Bossicard (*1972, Swiss) is an economist, a certified auditor and independent board member. With over 20 years of experience in technology, trade and industry, she has solid expertise in the relevant areas of strategic planning, finance and corporate governance.

As a long-standing chairperson of several audit committees for many years, C. Ritz Bossicard has a proven track record of experience in financial oversight, enabling her to ensure that the skills and knowledge which B. Krasna had brought to the ETH Board will be available to it in the future too.

› C. Ritz Bossicard

A complete overview of the vested interests of the members of the ETH Board can be found at www.ethboard.ch/en/vestedinterests.

Personnel matters

In memoriam

In 2020, the ETH Board, the entire ETH Domain and in particular the WSL had to say goodbye to dear friend, colleague and WSL Director, Prof. Dr Konrad Steffen. He had a fatal accident during an expedition in Greenland. We will remember Konrad Steffen as an extremely renowned researcher and a unique, generous and committed person.

Prof. Dr Konrad Steffen had been conducting research on climate change for more than 40 years, especially in the Arctic and Antarctic. He was a world-renowned expert in this field. Steffen studied natural sciences and obtained a doctorate at ETH Zurich in 1984. In 1990, he was appointed Professor of Climatology at the University of Colorado in Boulder, USA. He later also headed the Cooperative Institute for Research In Environmental Sciences (CIRES) there. Since 2012, he had been Head of the Swiss Federal Institute for Forest Snow and Landscape Research WSL. He was also Professor of Climate and Cryosphere at ETH Zurich and at EPFL in Lausanne.

Until the search for a successor has ended, his deputy Dr Christoph Hegg will take on the role of Acting Director of the WSL.

Personnel matters of the Federal Council

On 24 June 2020, the Federal Council elected the members of the ETH Board for the period from 2021 to 2024, appointing in the process long-standing member Barbara Haering as Vice President and Cornelia Ritz Bossicard as a new member of the ETH Board (also see p. 45). They replace incumbent Vice President Beth Krasna, who will step down at the end of 2020.

The President of the ETH Board, Prof. Dr Michael O. Hengartner, who has held this position since February 2020, was also re-elected.

ETH Zurich President, Prof. Dr Joël Mesot, and EPFL President, Prof. Dr Martin Vetterli, are members of the ETH Board by virtue of their position. Prof. Vetterli was already confirmed in his position of EPFL President on 12 February 2020.

The Federal Council also confirmed the appointments of Marc Bürki, Beatrice Fasana, Prof. Dr Susan Gasser, Christiane Leister, Prof. Dr Gian-Luca Bona as representatives of the research institutes and Dr Kristin Becker van Slooten as delegate of the university assemblies of ETH Zurich and EPFL.

Already in 2019, the Federal Council elected Prof. Dr Christian Rüegg as the new Director of the PSI for four years. Prof. Rüegg took up his position on 1 April 2020.

Personnel matters of the ETH Board

Appointments to the Executive Boards of ETH Zurich and EPFL

On 25 September 2020, the ETH Board appointed two new members of the ETH Zurich Executive Board and three new members of the EPFL Executive Board. The appointments at ETH Zurich are due to an expansion of the management structure from five to seven Executive Board domains. The new appointments at EPFL reflect an adjustment to the structure of the Executive Board for the second term of office of professor Vetterli, which runs from 2021 to 2024.

New members of the Executive Board of ETH Zurich

Dr Julia Dannath-Schuh, Vice President of Leadership and Personnel Development. She has been helping organisations in Switzerland and abroad drive forward their corporate and leadership culture for more than twelve years. J. Dannath-Schuh is a recognised HR expert with a PhD in psychology and is the author of several publications in her fields.

Prof. Dr Vanessa Wood, Vice President for Knowledge Transfer and Corporate Relations, is currently a professor in the Department of Information Technology and Electrical Engineering at ETH Zurich. She will continue her duties there on a reduced scale. Prof. Wood has been engaged in research into nanotechnology and batteries at ETH Zurich since 2011.

New members of the Executive Board of EPFL from 1 January/1 March 2021

Prof. Dr Gisou van der Goot is the new Vice President for Responsible Transformation. She initially studied engineering at École Centrale Paris, before starting her research career with a PhD in molecular biophysics. Prof. van der Goot subsequently lectured at the University of Geneva, leaving in 2006 to take up a position as Professor of Molecular and Cellular Microbiology at EPFL.

Prof. Dr Jan Hesthaven is the new Vice President of Academic Affairs. He holds a PhD in mathematical modelling from the Technical University of Denmark. Having worked for nearly two decades at Brown University, Prof. Hesthaven was appointed as Professor of Computational Mathematics and Simulation Science at EPFL in 2013.

Dr Matthias Gäumann takes over the new Vice Presidency for Operations, which he headed on an interim basis in 2020. He holds a PhD in materials science from EPFL and an MBA from the IMD business school in Lausanne. The ETH Board already appointed M. Gäumann as an interim member of the EPFL Executive Board on 21 July 2020.

Dr Ursula Oesterle is the new Vice President for Innovation. She holds a Master's degree in physics and chemistry from ETH Zurich, and a PhD in physics from EPFL. Her research in the field of quantum photonics at EPFL led to first interactions with industry research projects, and after completing further education at IMD in Lausanne U. Oesterle decided to completely move to industry.

Marc Bachelot is to take on the role of Acting Vice President for Finances. He graduated in engineering from École des Ponts in Paris and has held various financial operations posts in France, the USA, Italy and Switzerland during his career. M. Bachelot has been employed at EPFL since 2018. He is currently Director Contolling and Accounting within the Vice Presidency for Finances.

As a result of the mentioned structural adjustment of the Executive Board for Prof. Vetterli's second term of office from 2021 to 2024, the following members will leave the Executive Board of the EPFL at the end of 2020. The ETH Board would like to thank them sincerely for their work and commitment to EPFL.

Prof. Dr Pierre Vandergheynst, Vice President for Education, made innovation in education his central focus. Prof. Dr Andreas Mortensen, Vice President for Research, has negotiated many research contracts with the European Union with considerable success and tenacity. Prof. Dr Edouard Bugnion, Vice President for Information Systems, used his wealth of academic and industrial experience to restructure the information systems at EPFL. Caroline Kuyper, Vice President for Finances, successfully drove forward the restructuring of the finance department and strengthened the Vice Presidency for Finances. She has been CFO and Vice President for Finances at EPFL since 2017.

Appointments to the Directorate of the PSI

The ETH Board appointed Dr Thierry Strässle, who has been in charge of Directorate Support at the Paul Scherrer Institute (PSI) for many years, to the Board of Directors as Deputy Director. Th. Strässle studied physics at ETH Zurich, where he gained his doctorate in 2002. As Head of Directorate Support, he has been responsible for the operational management of the Board of Directors since 2012. From January 2019 until the end of March 2020, he was interim director of the PSI. Prof. Dr Gabriel Aeppli, who is currently a member of the Board of Directors, has also been appointed Deputy Director.

Appointments to the Directorate of Eawag

The ETH Board appoints Prof. Dr Carsten Schubert as a new member of the Directorate of Eawag. He will take up his new position on 1 April 2021, replacing Prof. Dr Alfred Johny Wüest, who has been a member of this body since 2015 and will leave as a result of his upcoming retirement. Prof. Schubert studied geology at Justus Liebig University Giessen (Germany) and joined Eawag in 2001. Like his predecessor, Prof. Schubert will represent Eawag Kastanienbaum in the Directorate.

Professorial matters

Refer to page 43 for information about the appointment of professors.

Risk situation and risk management

As the managing and supervisory body, the ETH Board sets out the risk policy for the ETH Domain. In this capacity, it has set targets for the two Federal Institutes of Technology and the research institutes. On the one hand, this serves to ensure that the tasks are performed effectively, cost-efficiently and with foresight, and that functional and innovative capability are maintained. On the other hand, this should guarantee personal safety and the security of property and other assets to the greatest possible extent. The leadership of the institutions of the ETH Domain is intended to be supported by comprehensive, transparent and up-to-date risk information and risk awareness among students and staff, and the good reputation of the ETH Domain is to be safeguarded.

All the institutions of the ETH Domain have their own procedures for risk management, which serve to identify and evaluate the individual risks, as well as strategies for coping with them and for monitoring them appropriately. In each institution, a risk manager and/or a risk committee coordinates the risk management activities and supervision of risk management procedures. Each institution keeps its own risk catalogue in which the identified risks are described in detail with an assessment on the basis of probability of occurrence and extent of the potential damage. This risk catalogue is updated at least once a year. In addition, consideration is given to the possible effect a risk could have on reputation. The individual profile, specific focus and size of each institution are reflected in its risk catalogue. Thus, the two Federal Institutes of Technology have different core risks to the four research institutes, and the assessment of the same risks can vary.

As part of their annual reporting to the ETH Board, the institutions provide information about their core risks, in particular their current status, extent and possible consequences. Core risks are those risks with potentially significant financial consequences and that have an above-average probability of occurring. They directly endanger the fulfilment of the legal duties. The reports on the core risks are then submitted to the department responsible for the ETH Domain. Moreover, the ETH Board must be informed directly by the institutions about any extraordinary changes in risk or damaging events.

The coronavirus pandemic was a major issue faced by the institutions of the ETH Domain in the reporting period. The risk of a pandemic was therefore reassessed and is now classified as a core risk. In addition to violence/threats against people and cyberattacks, the uncertainty in terms of funding developments (for example, the consequences of the pandemic for the economy and the Federal Government's financial situation) and the effects of an inhibiting political and legal environment (the relationship between Switzerland and the EU) are further core risks faced by the ETH Domain. Other risks include possible infringements of scientific integrity and good academic practice, taking on excessive obligations and the risk of a lack of oversight of long-term financial obligations and the consequences of such, as well as the loss of management and control due to the creation of external structures.

Despite careful risk management, it cannot be ruled out that an institution may be affected by a damaging event which endangers the fulfilment of its duties enshrined in law. In this case, the ETH Board would submit a request to the Federal Department of Economic Affairs, Education and Research (EAER), for the attention of the Federal Council, to adapt the strategic goals or increase the federal financial contribution in accordance with Art. 30(2) of the Ordinance on Finance and Accounting of the ETH Domain following consultation with the Federal Finance Administration (FFA).

The insurance policies taken out by the institutions are of great importance. The institutions must take out insurance against possible losses, subsidiary to other measures, where such insurance is feasible and the funding is sufficient for it. Each institution is responsible for taking out insurance cover and administering its own insurance portfolio. When doing this, it has to take into account its specific risk situation, strive for an appropriate cost/benefit ratio and ensure compliance with the federal regulations governing public sector procurement. The insurance cover must meet the standards which are customary in the Swiss insurance market and be concluded with an insurance institution that is licensed in Switzerland. The institutions have taken out property and employers' liability insurance policies, as well as smaller insurance policies for specific risks. The real estate owned by the Federal Government is not insured, because the Confederation follows a strategy of self-insurance.

STRATEGIC OBJECTIVES

Details of the Federal Council's strategic objectives for the ETH Domain can be found on the SERI website www.sbfi.admin.ch under Higher Education/ETH Domain.

Strategic objective TEACHING

In 2020, 35,235 students and doctoral students were enrolled at ETH Zurich and EPFL. One particularly difficult challenge was the switch to fully digital lessons in the face of the coronavirus pandemic. The fact that digital teaching and learning methods had been encouraged by both Federal Institutes of Technology for several years contributed to the rapid and smooth transition to online teaching.

Excellence in research and competence-oriented education

Education within the ETH Domain attracts a great many students and doctoral students from Switzerland and abroad. In 2020, 23,422 students and doctoral students were enrolled at ETH Zurich and 11,813 at EPFL, up 5.5% and 3.2% respectively compared with the previous year. The increase was particularly great in the fields of computer science and communication technologies (+12.4%). The proportion of women among students and doctoral students also rose again (2020: 32%; 2019: 31.7%). This also applies to the proportion of foreign students and doctoral students (2020: 47.7%; 2019: 47.5%). Their proportion is significantly higher at doctoral level than at Master's level and much higher than at Bachelor's level (for detailed figures on students and doctoral students, see the Monitoring Table and Academic Achievement Report, p. 86 ff.).

The two Federal Institutes of Technology are continuously developing their curricula strategically, with a view to reflecting the needs of society. For example, in the Autumn Semester of 2020, ETH Zurich launched a Bachelor's degree programme in Biochemistry – Chemical Biology, which offers theoretical and practical training in the subjects of chemistry, biochemistry and molecular biology, as well as a new Master's degree programme in landscape architecture, which is a pilot programme for Switzerland. EPFL focused particularly on the topic of sustainability where the expansion of its study programme was concerned and is preparing to launch a Master's in Sustainable Management and Technology and a minor in Sustainability. The Master's will be offered together with the University of Lausanne and is scheduled to start in the Autumn Semester of 2021. The promotion of transferable skills was central to doctoral training and was further expanded. This was demonstrated, among other things, by the introduction of the EPFLglobaLeaders programme, an initiative to acquire leadership skills in the context of Horizon 2020. Further funding was also secured for computer science training for teachers at secondary school levels I and II. Existing degree programmes have also been reorganised. Thus, the curriculum of the Bachelor's in Biology at ETH Zurich follows a new and innovative concept which uses evolutionary processes as a central theme in the curriculum. The first student cohort successfully completed their studies in the summer of 2020 in the Bachelor's degree programme in Human Medicine at ETH Zurich, which was newly introduced in 2017 and is now being permanently established (see Objective 5, p. 62 ff.).

The researchers from the four research institutions PSI, WSL, Empa and Eawag offer lectures, seminars and practical work, as well as other educational opportunities in various specialist fields. In 2020, this commitment corresponded to 18,553 teaching hours at a university in Switzerland or abroad (2019: 18717, see Fig. 11, p. 92). The slight decrease in these figures compared to the last two years can mainly be attributed to the consequences of the coronavirus pandemic. For

instance, various internships and summer and winter schools had to be cancelled. In addition, in the reporting period, the research institutions helped to supervise 608 Bachelor's and Master's theses and 842 doctoral theses. During the reporting period, over a dozen scientists from the research institutions were appointed professors at ETH Zurich, EPFL or another Swiss university and strengthened teaching at the universities concerned.

The institutions of the ETH Domain promote interdisciplinary dialogue and offer various platforms and courses which enable an exchange of ideas between those involved in MINT subjects on the one hand and social sciences and humanities on the other. For example, ETH Zurich has an interdisciplinary, specialised Master's degree programme called Science, Technology and Policy which enables the acquisition of knowledge and practical skills in the field of policy analysis in addition to in-depth scientific and technical studies. This Master's degree programme met with high demand in 2020. Individual classes of the programme were also attended by numerous students from other courses. At EPFL, four new Bachelor's courses are being prepared for natural and engineering sciences students who will convey management and finance knowledge. In addition, EPFL has expanded and strengthened the interdisciplinary projects of Discovery Learning Laboratories, particularly with regard to ethics and sustainability, and has also started planning for a Climate and Sustainability Week. The research institutions also contribute to interdisciplinary dialogue. For example Eawag, which offers the MOOC series Sanitation, Water and Solid Waste for Development in cooperation with EPFL. Since 2014, more than 150,000 people from 190 countries have participated. With its Advanced Landscape Research course in the context of the Master in Environmental Sciences at ETH Zurich, WSL enables the consideration of landscapes from an ecological, social and historical perspective.

Innovations and quality assurance in teaching

ETH Zurich and EPFL are developing and promoting new forms of teaching in the face of an increasingly digitalised workplace. This approach, which has already been followed in recent years, became particularly important in 2020 against the backdrop of the coronavirus pandemic and enabled an effective and rapid switch to distance learning. At EPFL, the lecturers particularly benefited from the experimental study on "flipped classrooms" which was concluded in the reporting period and showed the advantages of this approach. ETH Zurich also dealt with the shutdown by developing innovative teaching ideas. The switch to fully digital lessons took place in all departments within a very short time. With a view to the future, ETH Zurich is addressing the question of how the advantages of the new online methods can be optimally combined with those of face-to-face teaching. With the temporary resumption of teaching at the beginning of the Autumn Semester, EPFL established the concept of "flexible teaching", which aims for an efficient combination of face-to-face teaching and distance learning.

In order to ensure the quality of the courses, ETH Zurich and EPFL regularly carry out evaluations and accreditations. The results contribute to the further improvement of education. In the reporting period, ETH Zurich

ETH Zurich in "emergency operation mode": in March 2020, the university completely switched to online lessons.
› Nicola Pitaro/ETH Zurich

surveyed both students and lecturers about the switch to distance learning. The feedback was extremely positive and showed that the organisation and decision-making processes worked very well. EPFL also carried out similar evaluations in the spring of 2020. These results could be used for planning and providing information in the Autumn Semester. For instance, the students' need for a certain degree of personal contact was given due consideration. Some practical work and projects will therefore also take place on site, even after returning to distance learning at the end of October, by adopting appropriate protective measures. In addition, at the beginning of 2020, ETH Zurich decided to extend the option of dividing the basic examination into two separate examination blocks to all departments, as the results of a previous pilot test were all positive. In addition, ETH Zurich started to conduct regular surveys with doctoral students and will soon do the same with postdocs and senior research associates. The anonymous surveys conducted by an external institute are intended to provide continuous feedback on the satisfaction, support and development of non-professorial academic staff. At EPFL, a "Learning Companion" was developed, a digital tool that is intended to help students develop learning methods and organise their studies. Finally, both Federal Institutes of Technology invested the additional funds generated from the tuition fee increase decided by the ETH Board in 2018 in measures that improved the quality of teaching or the social support of students.

Promotion of national and international mobility

The institutions of the ETH Domain support the mobility of students in order to promote the exchange of experiences and ideas as well as the acquisition of language skills. Due to the coronavirus pandemic, far fewer students participated in an exchange programme at another university in 2020 than in previous years. Whereas international student mobility remained relatively unaffected in the Spring Semester, not least due to online courses, ETH Zurich recorded only about half of the usual outgoing mobility in the Autumn Semester. Mobility also decreased significantly at EPFL. Partner institutions were unable to accept students from the two Federal Institutes of Technology or the students themselves decided not to participate in their planned exchange programme. ETH Zurich completely cancelled the mobility programmes outside of Europe. Far fewer visiting students who come from another Swiss or foreign university to one of the two Federal Institutes of Technology attended ETH Zurich (317) and EPFL (378). These figures are considerably lower than in the previous year (2019: 467 and 593 respectively; see Fig. 7, p. 89).

Many other exchange formats also had to be cancelled. However, in January 2020, the PSI conducted an international winter school on the topic of proton therapy. More than 40 participants from 12 countries took advantage of this opportunity for specialist training and networking.

Mobility within the ETH Domain, which is supported in a variety of ways, also decreased in the reporting period. Five summer schools, which are jointly organised by doctoral students from the two Federal Institutes of Technology, had to be postponed. One summer school took place online.

The institutions of the ETH Domain are constantly concluding new international exchange agreements, in order to offer their students a wide range of possible exchange destinations. In the reporting period, EPFL concluded three new agreements with one Chinese and two European universities and was able to renew eight of the more than 150 existing agreements. ETH Zurich also has more than 100 partner universities in its exchange portfolio. In 2020, six existing partnerships with non-European universities were renewed and all exchange agreements in Europe were renewed for the coming academic year.

Strategic objective

RESEARCH

The researchers from the ETH Domain again compiled numerous remarkable studies in 2020 and received a large number of research grants and awards. The strategic focus area of "Energy Research" is now firmly enshrined in the institutions. Initiatives and projects related to digitisation are also making good progress.

Leading international position in research

A large part of the research carried out in the ETH Domain was understandably focused on COVID-19 in 2020 (see p. 12 ff.). However, other medical and life sciences projects in a more general sense were also completed in the course of the year. For example, EPFL conducted several studies in the field of neurosciences. In one of these, it was proven that the brain does not perceive received information continuously, but only at certain moments. These relatively counter-intuitive research results offer new perspectives in cognitive science. A team of researchers from ETH Zurich, the University of Zurich and the University Hospital Zurich were the first in the world to successfully develop a machine that can keep a donor liver alive outside the body for a week (see also p. 17). This enables the treatment of the liver before transplantation and opens up new perspectives for people with liver diseases. Empa researchers have succeeded in developing a wound dressing made of antibacterial cellulose which kills bacteria extremely efficiently. In the field of life sciences, researchers from PSI and EPFL achieved a scientific breakthrough in relation to cytochrome c, a protein essential for cellular respiration and thus for energy production. They discovered that the protein can swell in a completely unexpected way and hope to better understand its functions as a result.

The environment and biodiversity (see also p. 32 f.) are other important research areas of the ETH Domain. For example, biodiversity in meadows and pastures can have a positive effect on the economic output of farms. This was the conclusion of an interdisciplinary research team from the fields of agricultural science, ecology and economics at ETH Zurich and other universities. In cooperation with ETH Zurich, WSL has developed a new method for mapping certain plant species from moving vehicles. One of the goals of the joint project was to automatically detect invasive neophytes that spread along motorways in Switzerland and damage the environment. The project was funded by the Swiss Association of Road and Transportation Experts (VSS) and the Federal Office for the Environment (FOEN). Also in the field of biodiversity, a large-scale project conducted by Eawag and the University of Zurich showed that there are more than 40 native species of amphipods in Switzerland. Until recently, it was assumed that there were only about half as many. Since 2020, an online identification key for these species of amphipods has been available. In the field of environmental protection, a research team from EPFL has developed new materials that are able to purify air and water. This makes it possible, for example, to capture environmental pollutants or to extract recyclable materials from electronic waste. Of course, this is only a fraction of the many research projects that were completed in 2020.

The excellence of the ETH Domain's researchers is also reflected in the numerous awards and research grants they received in 2020. This includes the most important science prize in Switzerland, the Marcel Benoist Swiss Science Prize, which was awarded to Rudolf Aebersold, a professor at ETH Zurich and the University

of Zurich, for his pioneering research in the field of proteomics (see also p. 18). Maryna Viazovska from EPFL received the Latsis Prize, which honours the special achievements of young researchers, for her outstanding work in number theory (see also p. 22). The WSL Institute for Snow and Avalanche Research SLF received the Albert Mountain Award in 2020 for its systematic commitment to avalanche prevention. ETH Zurich and EPFL continue to hold top positions in the international rankings of the best universities in the world (see p. 95).

The ETH Domain also participates actively in the National Research Programmes (NRPs), including the NRP "Covid-19", and participates in the National Centres of Competence in Research (NCCRs). Of the six NCCRs launched in 2020, three are under the leadership or co-leadership of ETH Zurich, one of which is jointly led with EPFL. Empa and Eawag are also involved in two of these NCCRs. The researchers from the ETH Domain once again received several ERC grants: 15 Starting Grants, 3 Advanced Grants, 10 Consolidator Grants, 6 Proof of Concept Grants and – in collaboration with other institutions – 6 Synergy Grants (2019: 18 Starting Grants, 8 Advanced Grants, 6 Consolidator Grants, 11 Proof of Concept Grants, 3 Synergy Grants). In the Horizon 2020 call, the COFUND postdoc programme PSI-FELLOW was the only Swiss project which beat its strong international competitors. Another European initiative is the European Open Science Cloud Association (EOSC) which ETH Zurich helped to found. The aim of the association is to facilitate the free access of researchers to research data. The PSI has actively participated in and signed the Manifesto for EU COVID-19 Research to facilitate access to research results that could help fight the pandemic. Also in the context of open science, the institutions of the ETH Domain have drawn up a joint position paper that sets out their vision for free access to research data. The ETH Board adopted and published this position paper in 2020. Measures are currently being planned for the further implementation of open research data in the ETH Domain in coordination with the National Open Research Data Strategy.

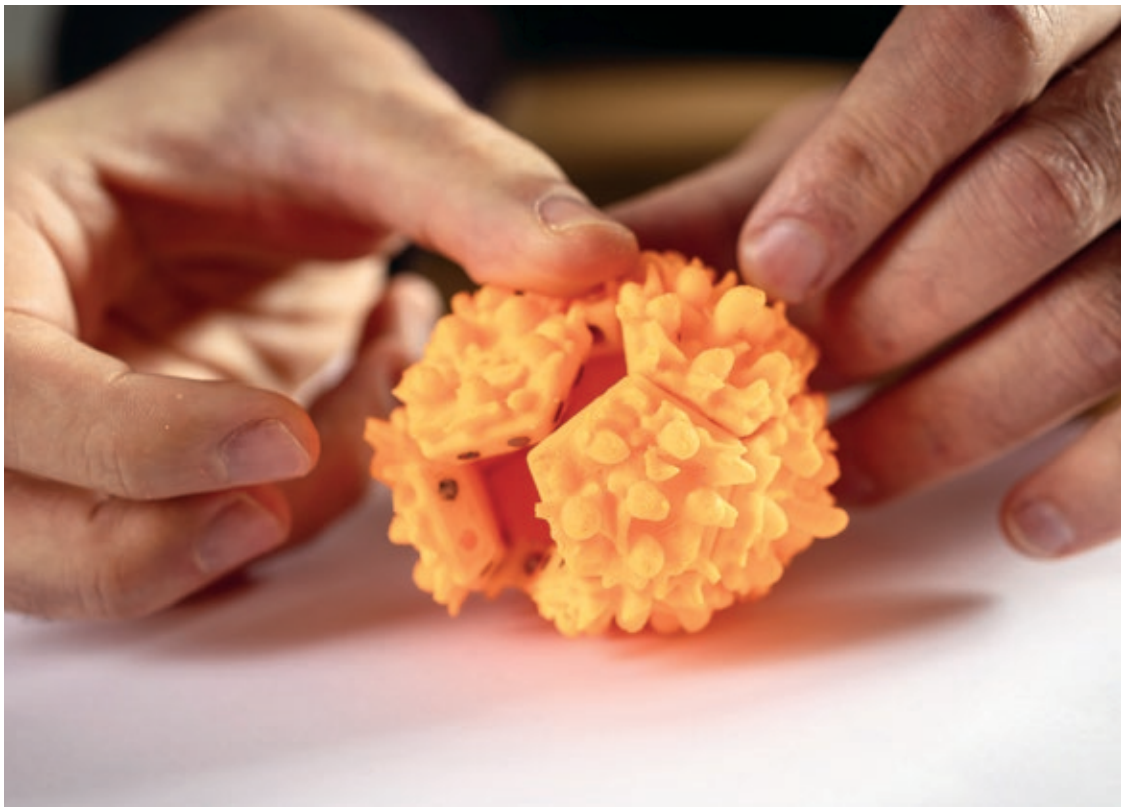
Research priorities

Energy Research is now very well anchored in the ETH Domain as one of the four strategic focus areas which the ETH Board had specified for the period from 2017 to 2020. Of the eight Swiss Competence Centers for Energy Research (SCCERs), seven were headed by one of the institutions of the ETH Domain. All were successfully completed in 2020. The researchers from the ETH Domain took an active part in the application process for the new SWEET (SWiss Energy research for the Energy Transition) funding programme of the Swiss Federal Office of Energy (SFOE). During the last two ERI periods (2013 to 2016 and 2017 to 2020), more than 20 professors were appointed, especially thanks to the special funds received from the Federal Government for energy research. This contributes to the long-term anchoring of energy research in the ETH Domain.

Numerous projects in the field of data science are being carried out in the context of the Swiss Data Science Center (SDSC), which is jointly run by ETH Zurich and EPFL. In 2020, several projects received a grant, including a PSI project. Its aim is to use machine learning techniques to develop new solutions for reducing the volume of data associated with the use of large-scale research facilities. Another project is the Empa-led Carbosense. A dense network of nationally distributed sensors has made it possible to visualise human-induced CO_2 emissions and the CO_2 concentration in the atmosphere in near real time. Together with the University of Florida, WSL and Eawag have launched a project that aims to use digital image processing – i.e. the capture and processing of images using artificial intelligence – for monitoring biodiversity and for ecological research. A study conducted by ETH Zurich, which was carried out jointly with EPFL researchers from the SDSC, finally points out for the first time that global warming can be proven in daily weather observations on a global level. Up to now, climate researchers had believed that climate change was not visible in specific weather observations.

Numerous projects were also carried out in the strategic focus area Advanced Manufacturing. For example, a miniaturised device for selective laser melting (SLM) was developed at the PSI. SLM is an important modern manufacturing process that enables 3D printing of metallic objects. The device developed at the PSI offers the possibility of examining the properties of the material by means of X-ray diffraction at the SLS during the printing phase (in operando) and thus optimising the production process. Empa also led several research projects in the context of this strategic focus area. One example is the development of a new method for quality control of 3D-printed metal parts using an acoustic sensor. The method used is based on artificial intelligence and enables the detection of microscopic production defects during the printing process. The new Design++ centre was also founded at ETH Zurich in 2020. The aim of the centre is to develop tools for advanced digital design and calculation processes in the construction sector.

Highlights of the focus area Personalized Health and Related Technologies (PHRT) are covered in Objective 5 (see p. 62 ff.).



The medicinal product of EPFL professor Francesco Stellacci puts the virus under increasingly severe stretching pressure until it bursts like a balloon. The clinical trials are about to get underway (see also p. 19 f.).

Enhancement of computer sciences and information technology at the two Federal Institutes of Technology

Six of the seven professorships that were earmarked in the additional federal funds to build up expertise in the field of digitisation are now filled. They supplement the large number of positions in the ETH Domain dedicated to computer science and information technology. Numerous other initiatives have been launched in the ETH Domain to hone skills in the field of digitisation. For example, ETH Zurich opened the ETH AI Center for artificial intelligence (see also p. 15 f.) and together with the PSI, it inaugurated a Center for Quantum Computing on the grounds of the PSI. In the Lake Geneva region, a new Trust Valley alliance was launched in the autumn of 2020 involving public, private and scientific partners, including EPFL. ETH Zurich and EPFL founded the Swiss Support Centre for Cybersecurity in 2020 as part of the National Strategy for the protection of Switzerland against cyber risks.

Academic integrity

The prerequisites for academic integrity and respect for it are above all training researchers and implementing consistent measures. With this in mind, ETH Zurich has launched a Workshop on Research Integrity which is aimed at doctoral students at the beginning of their studies. In the medium term, a mandatory course is also planned for doctoral students which will address scientific integrity and general and subject-specific aspects of research ethics. With the election of a third person of trust, ETH Zurich has also strengthened its resources for consulting and conflict resolution in this area. EPFL also supports the discussion of ethical issues via several internal, cantonal or national commissions. Under the leadership of the PSI, the guidelines on "Integrity in research" and the "Rules of procedure in the event of suspected breaches of integrity in research" were revised in parallel for all four research institutions. They entered into force in 2020. The institutions of the ETH Domain have also contributed to the development of the Code of Scientific Integrity which is being drawn up by the Swiss Academies of Arts and Sciences.

Strategic objective

RESEARCH INFRASTRUCTURES

The institutions of the ETH Domain develop and operate important research infrastructures which they make available to national and international partners. In 2020, important milestones were reached, not only in the implementation of the infrastructure, but also in terms of the research results achieved through the infrastructure.

Operation, further development and provision of large research infrastructures

The exceptional conditions of 2020 posed a challenge for the institutions of the ETH Domain which operate large-scale research facilities, but also opened up opportunities. At the PSI, for example, the activities of the Swiss Light Source (SLS) had to be reduced to five days per week from mid-March and external users were no longer allowed to enter. However, thanks to the set of precautionary measures worked out by the research institute, normal 24/7 operation was resumed as early as June. Remote access to facilities for external use and analysis services for samples sent in have been significantly extended, which will continue to benefit the scientific community in the future. In March 2020, the PSI issued a Priority COVID-19 Call which provides priority access to SLS for projects that contribute to the understanding of SARS-CoV-2. The call led to numerous fruitful cooperation agreements, especially on an international level. One example of this is a study published by a team of scientists in Frankfurt in the journal Nature, in which possible vulnerabilities of the virus were identified, which can be a starting point for the development of new medicinal products. Researchers from the Max Planck Institute in Munich also contributed to the structural elucidation of a fragment of a highly immunogenic virus protein. This is particularly thanks to the "Jungfrau" detector installed on the SLS beamline and an innovative data acquisition system developed at the PSI. As a result of the coronavirus pandemic, the figure of almost 1,100 users of the PSI's large-scale research facilities was significantly lower than in previous years. The number of experiments carried out, on the other hand, was maintained almost at the level of recent years, as many of the samples to be examined from Switzerland and abroad were sent to the PSI and analysed by researchers from the PSI. Around 50% of the testing time slots were assigned to Swiss researchers, the vast majority of whom came from the ETH Domain. On average, the experimental stations at the large facilities are overbooked by a factor of 2 to 2.5. The overbooking of individual facilities is even significantly higher. The use of the SLS by industry remains at a high level of around 14%.

In 2020, the User Lab provided IT resources at ETH Zurich's Swiss National Supercomputing Centre (CSCS) via various project calls. A total of 119 projects were approved in 2020 as part of two national calls and the European PRACE (Partnership for Advanced Computing in Europe) call. The applications for computing time exceed the available capacity by a factor of three to four. This year, the 2,000-user mark was exceeded.

The EPFL's Swiss Plasma Center (SPC) is Switzerland's national laboratory for fusion research and plasma physics. It is operated as part of the EUROfusion consortium and contributes to the ITER (International Thermonuclear Experimental Reactor) project. The installation of new plasma heating systems in the Tokamak reactor at SPC, which was supported by the ETH Board, has enabled the identification of and research to be conducted on plasma configurations and

conditions that are also promising for ITER. The SPC's superconductivity for fusion research group, which is affiliated with the PSI, has almost finished characterising the conductors for the ITER magnets which form the basis for plasma confinement. Thanks also to these contributions, the assembly phase commenced at ITER from July 2020 onwards.

In 2020, several large-scale research facilities were developed and upgraded to ensure that they maintain their long-term competitiveness and their benefits for the Swiss scientific community and industry. For example, the upgrade of the neutron guides of the Swiss Spallation Neutron Source (SINQ) at the PSI was completed. Their users can now rely on the most modern neutron optics in the world. An important milestone was reached in the construction of the "Hilo" unit of the NEST research and innovation building of Empa and Eawag: the doubly curved concrete roof is now finished. The construction methods for this complex concrete construction were developed by researchers from ETH Zurich in cooperation with industry partners.

Swiss Roadmap for Research Infrastructures: implementation of the strategic projects

Work proceeded on the ETH Domain's projects included in the Swiss Roadmap for Research Infrastructures 2017–2020 (Roadmap 2015), the key planning tool of the Federal Government. The expansion of the SwissFEL X-ray free electron laser was continued at the PSI in 2020. Despite the pandemic, the assembly of the second beamline ATHOS continued with only slight delays, so that in June X-ray light was supplied to the Maloja experimental station for the first time. Another highlight: for the first time, the parallel measuring operation was realised on the two beamlines ARAMIS and ATHOS. According to the current schedule, the Maloja experimental station will become operational in 2021 and enable first experiments with ultra-fast, soft X-ray pulses. The EPFL's Blue Brain Project (BBP) is aimed at digitally reconstructing and simulating the brains of rodents and ultimately that of humans. The project is on track where the most important scientific milestones are concerned, although there was a slight delay due to pandemic-related restrictions (see also p.9). In 2020, BBP increased its high-performance scientific computing resources with the purchase of the Blue Brain 5 supercomputer which is hosted at CSCS. New data, novel in silico models and open-source software have been published on the BBP virtual portal. Finally, the project also provided resources to combat the pandemic (see also Objective 7, p. 68 ff.).

Considerable progress was made in relation to the new infrastructures of the Roadmap 2019 for the period from 2021 to 2024 in terms of preparing for their implementation. A major milestone in the implementation of the HPCN-24 (High Performance Computing and Networking) strategy is the strategic partnership of CSCS with supercomputer manufacturer Cray (now part of Hewlett Packard Enterprise). This paved the way for the new hardware and software infrastructure that will replace the Piz Daint supercomputer. The Catalysis Hub "Cat+" is a research infrastructure of the two Federal Institutes of Technology in cooperation with Empa. Its aim is to research catalytic processes, in order to produce new commodities based on renewable energies.

In March 2020, the PSI issued a Priority COVID-19 Call which provides priority access to SLS for projects that contribute to the understanding of SARS-CoV-2.

For the SLS 2.0 upgrade see p. 23 f.

The infrastructure consists of an east hub and a west hub. In 2020, directors were appointed to both hubs and the infrastructure is scheduled to be commissioned in 2021. At the PSI, the design phase for the upgrade of SLS (SLS 2.0, see p. 23 f.) was completed during the reporting period.

Involvement in international research infrastructures

The institutions of the ETH Domain are also involved in major research infrastructures and important projects at European and international level. For example, ETH Zurich is involved in the research infrastructure EPOS (European Plate Observing System). EPOS creates a uniform platform on which the earth science measurement data of tens of thousands of sensors and analyses derived from them are openly accessible. ETH Zurich is also involved in the development of one of the first three instruments of the European Southern Observatory's (ESO) Extremely Large Telescope (ELT).

In 2020, EBRAINS was launched, a new digital research infrastructure within the framework of the Human Brain Project (HBP), which was initiated by EPFL and selected by the EU as an FET Flagship project. This state-of-the-art infrastructure is intended to strengthen Europe's position in the field of multidisciplinary neuroscientific research and to make the latest scientific findings of brain research accessible for the purposes of innovation, industry and medicine. At the end of the last financial period (until 2023), EBRAINS AISBL, a Brussels-based company, will assume responsibility for the coordination of HBP. It will create research infrastructure that is intended to exist beyond the project and at the same time benefit from its results. In September 2020, EBRAINS submitted an application for the roadmap of the European Strategy Forum on Research Infrastructures (ESFRI).

EPFL and ETH Zurich are participating in the Swiss-Norwegian Beamline at the European Synchrotron Radiation Facility (ESRF) in Grenoble, together with other Swiss research institutions. EPFL will take over the coordination of the Swiss participants from 2021 onwards. The Swiss-Norwegian Beamline offers access to high-performance X-rays and enables unique diffraction and absorption experiments. Empa also performed measurements at ESRF in 2020, during which it monitored additive manufacturing processes in real time. In addition, EPFL was granted the status of a member of the organising committee of the international consortium Square Kilometer Array (SKA), which is building the largest radio telescope ever to be assembled. Among other things, EPFL will be responsible for coordinating the scientific contributions of the nine Swiss institutions involved in the project – including ETH Zurich.

The PSI is participating in the realisation of the European Spallation Source (ESS) in Lund, Sweden, in particular through the assembly of the ESTIA reflectometer, which has been in progress since July 2020. In addition, the PSI, together with international partners, built several components of BIFROST, ESS's spectrometer for extreme operating conditions. As part of the integrated European infrastructure for researching long-term ecosystems, critical zones and socio-ecological systems (eLTER RI), which was included in the ESFRI Roadmap 2018, two projects were launched in 2020 to prepare for the implementation and commissioning of eLTER in 2026. The aim of the consortium is to promote the operational, technical and strategic development of existing research spaces in Europe. As a result, solutions to the challenges of global ecological change are to be found by means of holistic and systemic observations and analyses of environmental trends. WSL brings its expertise, data and infrastructure from 19 long-term research spaces for forest ecosystems to the table.

Strategic objective

KNOWLEDGE AND TECHNOLOGY TRANSFER

With numerous patents, new cooperation agreements and another record number of spin-offs, the institutions of the ETH Domain also contributed to the transfer of knowledge and technology in 2020 and thus to Switzerland's innovative strength. An important role is also played by the continuously expanding further education programme. In addition, the institutions once again strongly committed themselves to the generational project of the Swiss Innovation Park.

Enhancing Switzerland's innovative strength and competitiveness

By transforming scientific findings into marketable products and services, the ETH Domain makes a significant contribution to Switzerland's competitiveness. This knowledge and technology transfer (KTT) is documented in the reporting period by 310 invention registrations and 32 software registrations as well as 217 patents and 338 licences. This corresponds to a similar scope to that of previous years (see Fig. 12, p. 93). The traditional, large networking events of the two universities with industry took place in a digital format in 2020. At ETH Zurich, 400 people attended the virtual ETH Industry eWeek with short lectures and project videos from researchers, young ETH entrepreneurs and industry representatives. The FORWARD innovation forum at EPFL was also extremely successful in converting to a digital format with around 900 participants. The continuously updated information offers are also important for networking with industry. The ETH News for Industry portal was widely used in the reporting period and now has several thousand subscribers. At the same time, ETH Zurich is now also offering concrete advice on issues relating to Innosuisse's project funding. In French-speaking Switzerland, the Alliance innovation programme was supplemented by the RAPID Alliance tool which shows companies the various academic skills at EPFL and the other universities in Western Switzerland.

Basically, it can be said that even in the pandemic year 2020, the ETH Domain and the business community worked well together and the long-term relationships paid off. This is illustrated not least by the substantial amounts that companies such as Roche, Hilti and Clariant donated for research initiatives at ETH Zurich in the reporting period. The 610 new cooperation agreements concluded in 2020 by the institutions of the ETH Domain with the private sector and the 262 cooperation agreements concluded with the public sector also refer to the close cooperation with national and international companies as well as with public authorities (see Fig. 13, p. 94). For example, the PSI, together with Thuner SME TOFWERK AG, has developed a novel mass spectrometer, thanks to which our understanding of cloud formation and air pollution has been significantly expanded. In the meantime, TOFWERK has successfully launched the device on the market. With the company Solaronix SA, which is based in Western Switzerland, Empa developed a faster and cheaper production process for highly efficient solar cells. Together with authorities and practitioners, Eawag has developed a planning aid for the elimination of trace substances from urban waste water by means of activated carbon filters (see also p. 34). Together with the Federal Office for the Environment (FOEN), WSL launched the Tree App in the autumn of 2020. The app helps Swiss forest experts to select the ideal tree type for a

specific location, with due consideration given to climate change. The institutions of the ETH Domain also carry out international KTT in a systematic manner, supporting the humanitarian foreign policy objectives of the Federal Government. In order to combat the pollution of drinking water with arsenic and fluoride, Eawag has developed, with financial support from the Swiss Agency for Development and Cooperation (SDC) and together with two companies, an interactive platform for the assessment and map-based prediction of groundwater quality. Also with the support of the SDC, ETH Zurich was able to develop a simple and low-cost ventilator as part of the "breathe" project which was produced in an initial small-scale series in Ukraine and supplied to healthcare centres there.

National network of technology transfer centres in Advanced Manufacturing

The ETH Domain plays a key role in the establishment of a network of technology transfer centres in the Advanced Manufacturing sector. This is being promoted in the context of the Federal Government's Digitisation Action Plan (see also Objective 2, p. 53 ff.). In 2019, the umbrella association of technology transfer centres was established at Empa. In the autumn of 2020, the Swiss m4m Center – initiated by Empa and supported by the cantons of Solothurn and Bern – was officially opened. It is active in the field of patient-specific production of 3D-printed medical implants and now has more than 40 partners. The ANAXAM technology transfer centre offers companies services in the field of applied material analysis by means of neutron and X-ray radiation at the PSI's large-scale research facilities. In the reporting period, ANAXAM completed the establishment of the office, moved into the Park Innovaare's deliveryLAB premises and started numerous new projects with industrial companies. The Aargau Cantonal Parliament approved a grant of CHF 2.4m for the period from 2021 to 2024.

Further education

The further education programmes of the institutions of the ETH Domain are making a decisive contribution to the transfer of knowledge and skills to the economy and society. The research institutions offer a wide range of services in their specialised fields. The Empa Academy organises courses for external third parties on topics such as electrochemical corrosion or additive manufacturing of metals. Some of the practice-oriented Eawag courses (PEAK) on water and fish monitoring or trace analysis took place in hybrid form in 2020 and were aimed at both German and French-speaking audiences. The Forum for Knowledge 2020: Biodiversity in the Swiss Forest, attended by around two hundred experts from practice and administration, took place entirely virtually at the WSL in the reporting period. The CAS programme Leadership in Science, jointly offered by the University of Applied Sciences and Arts Northwestern Switzerland (FHNW) and the PSI for managers of the four research institutions, was continued without interruption in 2020 thanks to distance learning.

The two Federal Institutes of Technology have a very extensive range of further education programmes, which was further expanded in 2020. ETH Zurich offers seven CAS programmes more than in the previous year, including the Entrepreneurial Leadership in Technology Ventures course. The first series was already fully booked. Ten additional further education programmes are currently being developed. In addition to its joint offer with the University of Lausanne, EPFL is constantly offering new specialised further education courses in areas such as management, data protection and data science for individual stakeholders. At the Extension School with digital technology offerings, 60 people, including refugees and doctoral students, received the My Digital Future fellowships for free participation in web development courses.

Favourable conditions for KTT and enterprise

By awarding scholarships, the institutions of the ETH Domain promote the entrepreneurial commitment of their students and researchers. In the reporting period, ETH Zurich was awarded the 100th Pioneer Fellowship. Thanks to the ETH Zurich Foundation, many of these fellowships, which also include support and coaching from the Innovation & Entrepreneurship Lab, can be funded from donations. Other funding is also being raised together with partner organisations. "Startfeld", the network for start-ups in St.Gallen which Empa is involved in, provided more than 150 initial consultations and awarded funding to several companies in the reporting period. At EPFL, the various funding programmes were regrouped and supplemented by the Ignition Grants, which provide support in the early stages of a project. Together with the Gebert Rüf foundation, the Enabled-by-Design platform for entrepreneurial cooperation in the field of design was also launched.

The spin-offs, which often arise from these funding programmes, turn innovative research into popular products or services. In 2020, 66 spin-offs were newly founded in the ETH Domain (see p. 93). This number clearly surpasses the previous year's peak again. Companies such as Neurosoft Bioelectronics (nerve implants made of elastic materials) or Auterion (software for drones), which emerged from EPFL and ETH Zurich respectively, developed exciting new products and services for the market and society. The start-ups of the ESA Business Incubation Centre Switzerland gave the Swiss flagship incubator of the European Space Agency (ESA) a rating of 9.6 out of 10 points in the reporting period. The early renewal of the contract with ETH Zurich as the institution in charge is already in the process of being finalised. A joint spin-off between ETH Zurich and the PSI won the Venture Leaders Life Sciences 2020 award with Araris Biotech AG. The company, which was founded in the context of a PSI

With the support of the SDC, ETH Zurich developed a simple and low-cost ventilator for health systems in low and middle-income countries as part of the "breathe" project.
› breathe/ETH Zurich

Founder Fellowship, has already raised a total of CHF 15m in initial funding. Empa, Eawag and WSL also recorded the foundation of spin-offs in the reporting period, such as Urban Sympheny AG for smart energy solutions for districts (see also p. 30), Entracers GmbH in the area of gas monitoring or TerraRad Tech AG, the first WSL spin-off, which can use a drone to measure the moisture content in the soil from the air and thus help to maximise the revenue of farms by optimising irrigation. The Empa spin-off anavo, which is developing a nanoparticle-based wound adhesive for faster and safer wound healing, was awarded the tenth Innovation Award by Empa. A new study conducted by the University of St.Gallen on the spin-offs of ETH Zurich and their performance also confirms the long-term success of these companies. By the end of 2018, around 4,500 jobs had been created – on average more than 30 per spin-off – which is well above the Swiss average (see also p. 18).

Strong involvement in Switzerland Innovation

In all parts of the country, the institutions of the ETH Domain are involved in the generational project of the Switzerland Innovation Park. In spite of renewed delays in the Switzerland Innovation Park Zurich, ETH Zurich is continuing to play a pioneering role and is placing further emphasis on the development of the park: since the autumn of 2020, the rented and converted spaces in Hangar 3 on the Dübendorf airfield have been gradually filled by teams of students and researchers, mainly from the Robotics and Mobility sector. The EPFL Innovation Park Lausanne is now 100% full and has a waiting list for other interested companies. In the reporting period, the Park Network West EPFL in French-speaking Switzerland drew up the strategy for the period from 2021 to 2024 and significantly increased the annual payments of the funding bodies. EPFL was also entrusted with the Switzerland Innovation Tech4Impact Initiative. It covers all Swiss parks for the first time and supports six projects with a focus on technology and sustainability. The expansion of PARK innovAARE, which is located in the immediate vicinity of the PSI and now comprises a total of 17 companies, continued in 2020. The PSI provides substantial support in the implementation of the settlement strategy, which focuses more closely on research and development departments of large companies operating on an international scale. In mid-2021, the "Innovationspark Ost", which is supported by the canton of St.Gallen and is located right next to the Empa site there, is to be set up as another Switzerland Innovation site. In cooperation with the city of Thun and the canton of Bern, the establishment of a start-up cluster and close cooperation with the Switzerland Innovation Park Biel/Bienne are also planned at the Empa site in Thun.

Strategic objective

NATIONAL COOPERATION AND COORDINATION

In the reporting period, the institutions of the ETH Domain collaborated with each other and with other educational and research institutions on a variety of projects. They also participated in the shaping of the Swiss higher education sector. In close cooperation with the hospitals, medical and data-related health research was further strengthened.

Cooperation within and outside the ETH Domain

The six institutions of the ETH Domain are in close contact with each other through joint Master's degree programmes, the participation of the research institutions in teaching or the joint supervision of doctoral students. In 2020, the institutions worked together quickly and successfully, especially also in the face of the pandemic (see also Objective 7 p. 68 or p. 12 ff.). In research, strategic focus areas and state-of-the-art research infrastructures are important drivers of cooperation. In the year under review, the ETH Board decided to further strengthen cooperation projects in the context of one-off funding from reserves from 2021 onwards. Among the six projects is the research initiative Blue-Green Biodiversity Research Initiative (BGB), see also p. 33), a collaboration between Eawag and WSL with the aim of researching biodiversity at the interface of aquatic and terrestrial ecosystems. Within the framework of the cooperation projects, the PSI is participating in, amongst other things, a new joint laboratory for the development of multifunctional high-performance materials on the Höng-gerberg campus of ETH Zurich. The PSI and Empa started a collaboration agreement on the development of synthetic fuels from renewable resources. ETH Zurich and EPFL entered into a partnership with the International Committee of the Red Cross (ICRC), in order to use the skills and technologies of the two universities specifically for humanitarian aid.

Other examples of joint initiatives in the reporting period include the Climate Change, Extremes, and Natural Hazards in Alpine Regions Research Center CERC in Davos, which the WSL and the canton of Graubünden founded and which ETH Zurich participates in. Starting in January 2021, its research will focus on socially and economically relevant issues relating to climate change, extreme events and natural hazards in mountainous regions (see also p. 28). Together with several companies and the support of the canton of Vaud, EPFL founded the non-profit association Swiss Food & Nutrition Valley. The aim is to establish a unique ecosystem for innovations in the field of nutrition and ecologically responsible food. After all, a large number of cooperation agreements exist at the level of research groups. For example, researchers from Eawag worked with researchers from ETH Zurich to investigate how microbes interact in the sediment of nutrient-laden lakes or, together with researchers from EPFL, how adaptation to warmer environmental conditions strengthens the resistance of viruses.

The collaboration within the ETH Domain is complemented by a diverse exchange of ideas with other Swiss educational and research institutions. At a structural level, this is reflected by the establishment of centres or networks. In 2020, EPFL, together with the canton of Bern and the three Bern universities, laid the foundations for a centre for digital education research in the canton of Bern. Together with the universities of Basel and Zurich and two companies, ETH Zurich is setting up a new technology platform, the Swiss Ultrahigh-Field Solution NMR Facility for

the analysis of biomolecules. In the reporting period, Empa committed itself by organising the events Swiss Advanced Manufacturing Community Events to establish an exchange of ideas on advanced manufacturing across institutions and disciplines. In addition to such structural partnerships, the joint research projects play an important role. Under the leadership of Eawag, a multidisciplinary research team is investigating the dangers posed by Legionella as part of the LeCo project (see also p. 34). In cooperation with the Lucerne University of Applied Sciences and Arts, the Swiss Tropical and Public Health Institute (Swiss TPH) and the Kantonales Labor in Zurich (cantonal laboratory), the fight against these bacteria is to be intensified in Switzerland. Under the leadership of the University of Applied Sciences Northwestern Switzerland, the PSI participated in the development of the Swiss STIX X-ray telescope, which was successfully launched into space in 2020 with the European Space Agency's (ESA) Solar Orbiter mission. PERMOS, which was founded in 2000 as the world's first permafrost measurement network and whose coordination is based at the WSL Institute SLF, celebrated its 20th anniversary in the reporting period. The network, supported by numerous actors, documents the warming of permafrost in the Swiss Alps.

Strategic alliances

A special form of cooperation exists between ETH Zurich and EPFL and some research facilities of national importance funded by the Federal Government. As part of the strategic alliance between ETH Zurich and inspire AG, the competence centre for technology transfer to the mechanical, electrical and metal industries, more than 80 projects were carried out in the area of manufacturing and production technology in the reporting period. One highlight was a valve equipped with new state-of-the-art sensors for use in hydrogen technology, which was successfully launched on the market. In addition to the close cooperation on research and development, inspire AG supports ETH Zurich through lectures or the supervision of student work.

EPFL is in close contact with the Swiss Center for Electronics and Microtechnology (CSEM), especially through its Neuchâtel site. An important project launched in 2020 between CSEM and the EPFL's Photovoltaic Laboratory is Hyperion, which aims to increase the capacity for manufacturing photovoltaic panels in Europe. Another strategic alliance exists between EPFL and the Idiap Research Institute in Valais, which specialises in information technology and artificial intelligence. More than 40 doctoral students who are enrolled at EPFL's Electrical Engineering or Computer and Communication Sciences doctorate schools are currently working at Idiap.

Implementation of the Federal Act on Funding and Coordination of the Swiss Higher Education Sector (Higher Education Act, HEdA)

ETH Zurich and EPFL are closely involved as members of swissuniversities in the design of the Swiss higher education sector in accordance with the HEdA. Since February 2020, the President of ETH Zurich has been on the Board of the Rectors' Conference of Swiss Universities. Both universities are currently in the process of seeking institutional accreditation of their institutions in accordance with HEdA. EPFL will start its self-evalu-

At the new CERC in Davos, socially and economically relevant questions about climate change, extreme events and natural hazards in mountain regions will be researched from January 2021. ETH Zurich is participating by filling two professorships (see also p. 28).
cerc.slf.ch
› Clemens Güdel

ation phase in January 2021, and ETH Zurich was already reviewed by a panel of experts in 2020. In addition, EPFL plans to renew the accreditation or re-accreditation of individual degree programmes at its university by the French state.

All institutions of the ETH Domain are also involved in the cooperation projects which the Federal Government funds in the context of the project contributions. From 2021 onwards, the research institutes of the ETH Domain, which had successfully participated in these programmes in the past, are no longer eligible for contributions. The ETH Board has therefore decided to allocate the financial resources centrally for specific participation of the research institutes. For example, two project applications with the PSI as project partner could already be submitted in response to the calls launched in the reporting period. Empa also participated in an application in this way with Materials Cloud – an Open Science Platform for materials science. Good progress was also made on the consolidation of major individual cooperation projects in the reporting period. The ETH Zurich Library plays a key role within the Swiss Library Service Platform. At the end of 2020, the latter launched the new library software Alma, an important intermediate step for accessing scientific information from libraries throughout Switzerland. For the long-term management of the Swiss MOOC Service set up by EPFL, the two Federal Institutes of Technology have founded an association that will also offer a fee-based service for private actors on the continuing education market from 2021 onwards.

Activities in the area of medicine and medical technology

Within the framework of the strategic focus area Personalized Health and Related Technologies (PHRT) of the ETH Domain for the period from 2017 to 2020, a total of 55 research projects deepen interdisciplinary cooperation with hospitals. Significant progress has been made on preparatory work for two other technology platforms on the topics of imaging and data analysis, which are to supplement the existing platforms on genomics, proteomics and metabolomics. In addition to the focus area, there are a large number of other partnerships between the ETH Domain and institutions from the healthcare sector. More than 30 projects are currently under way at Empa in cooperation with hospitals or in the medical technology sector, for example a joint venture with the Kantonsspital St.Gallen (cantonal hospital) on a sensor system for the early detection of Alzheimer's disease. In the reporting period, the PSI strengthened its long-standing cooperation with the Kantonsspital Aarau (cantonal hospital) by planning a study on possible advantages of proton therapy in the treatment of lung tumours. In cooperation with the University Hospital Basel and the Debiopharm company, it also achieved success in the targeted fight against thyroid cancer. The first prototype of a device for precise radiation therapy, developed by a doctoral student at EPFL in collaboration with CERN, is also used for cancer treatment. In the field of neuroscience, the Catalyst Fund at EPFL funded six projects involving research on vital treatments. In the reporting period, ETH Zurich decided to support SKINTEGRITY for a further four years and to transfer it to Open ETH (formerly ETH+). In this flagship project of the University Medicine Zurich, research is being conducted on novel diagnostic methods and therapies for skin diseases and wound-healing disorders. ETH Zurich has recently launched the Competence Centre for Rehabilitation Engineering and Science (RESC), which works closely with patients.

As far as budding young medical professionals are concerned, ETH Zurich came to a very positive conclusion on the pilot course of its Bachelor's degree programme in human medicine in the reporting period and decided to make it a permanent part of its curriculum and to continue to admit 100 students per year. In the summer of 2020, 20 students transferred to the University of Zurich, another 20 transferred to the University of Basel and a further 37 from the first cohort transferred to the Università della Svizzera Italiana to complete their Master's degree. The remaining students did not pass the basic examination at the first attempt and have transferred to the next cohort or have changed or abandoned their course of study. Only three students who completed the Bachelor's degree in Life Sciences Engineering at EPFL were admitted to the "Passerelle" of the University of Lausanne's medical faculty in the reporting period, partly due to the coronavirus pandemic. Ten places are again planned for next year.

Strategic objective

INTERNATIONAL POSITIONING AND COOPERATION

In 2020, the ETH Domain continued to expand and underpin the position of its institutions as education and research players of global importance. This is not least thanks to an extensive alliance network as well as international cooperation projects and initiatives.

Attractiveness of the ETH Domain

The coronavirus pandemic has affected overall international mobility, especially for students, doctoral students and researchers from non-European countries (see Objective 1, p. 50 ff.). Nevertheless, the institutions of the ETH Domain have continued various activities in order to make themselves more appealing to the best international students. For example, ETH Zurich organised a series of events in Switzerland and abroad as part of ETH Meets You, where local experts and ETH Zurich experts from the fields of science, business and society were able to share their views on current issues and maintain a dialogue with an international audience. In 2020, EPFL's 50-Fifty Campaign continued, a fundraising drive launched on the occasion of its 50th anniversary. The funds collected will be used to finance the Student Support Programme, which among other things awards Master's degree level excellence fellowships to the best students from Switzerland and abroad.

The international exchange programmes also strengthen the ETH Domain's appeal to the world's best researchers. Their recruitment contributes significantly to the quality of the institutions. In 2020, ETH Zurich awarded 27 fellowships as part of the ETH Fellows programme which supports international postdocs. Thanks also to the COFUND programme of the European Marie Skłodowska-Curie Actions (MSCA), promising young researchers from all over the world are supported. The PSI FELLOW-III-3i COFUND programme, which was successful in 2020, is aimed at international postdocs. In addition, the PSI is also coordinating other international MSCA programmes, including in the fields of proton therapy, neutron and energy research.

International cooperation

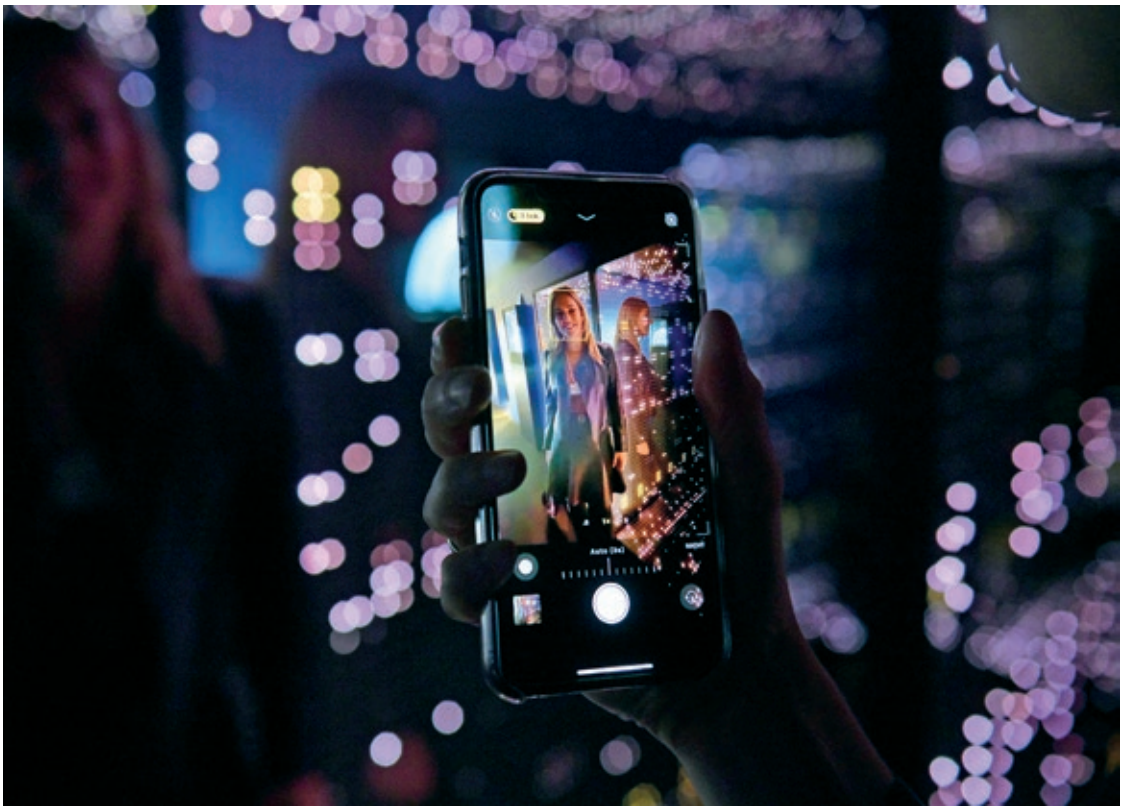
The institutions of the ETH Domain belong to various international networks and strategic alliances. Both Federal Institutes of Technology are members of, amongst other things, CESAER (the European network of universities of science and technology), the International Sustainable Campus Network (ISCN) and the Global University Leaders Forum (GULF), a platform of presidents of leading universities. These cooperation and collaboration networks are maintained, among other things, through the organisation of events and the participation of the institutions in international events. For example, ETH Zurich was able to adress a broad Swiss and international audience with its pavilion on the topic of RETHINKING Creativity at the World Economic Forum (WEF) in Davos in 2020. EPFL is also a member of the EuroTech network, a strategic partnership of six of the most important universities of science and technology in Europe. As part of this alliance, it organised an online summer university for doctoral students and postdocs. Other events planned under the EuroTech Universities Alliance, such as EuroTech Innovation Day, had to be postponed due to the coronavirus pandemic. Finally, thanks to a scholarship agreement with the Taiwan Ministry of Education, EPFL was able to accept three Taiwanese doctoral students. Meanwhile, eight doctoral students from EPFL are successfully continuing their studies in Taiwan.

The institutions of the ETH Domain are also involved in important projects on the international stage. One example is the Ice Memory project, which the PSI is participating in under the auspices of the French and Italian UNESCO commissions. The project's aims are to collect and ensure the long-term preservation of samples of glaciers that contain unique information on climate change over the past centuries, but which are threatened by global warming. In the autumn of 2020, PSI researchers had to break off the expedition to the Grand Combin Glacier due to the drilling difficulties they experienced. This shows how much the glaciers in this region are already affected by global warming. From autumn 2019 to 2020, researchers from WSL and the PSI, together with researchers from twenty other nations, took part in the MOSAiC expedition (Multidisciplinary Drifting Observatory for the Study of Arctic Climate) aboard the icebreaker Polarstern which drifted through the Arctic Ocean. The aim of this expedition, organised by the Alfred Wegener Institute, is to better understand the Arctic's influence on the global climate. Eawag, in collaboration with 34 researchers from around the world, participated in a study on the potential risks associated with the presence of SARS-CoV-2 viruses in waste water. The results of this study were published in the journal Nature Sustainability (see p. 12). Empa is working with the European Space Agency (ESA) to develop a satellite system for monitoring CO_2 emissions. In addition, together with a team of researchers from Imperial College London, it is developing drones that can, for example, equip trees with sensors to detect environmental damage in forests.

In 2020, researchers from the ETH Domain also launched several initiatives to strengthen international cooperation. At Eawag, a team of three researchers developed a new concept for scientific conferences: ABCD (All continents, Balanced gender, low Carbon transport and Diverse backgrounds). The new approach is intended to enable researchers from all over the world, from all sexes and from different cultural or ethnic backgrounds to get involved and reduce the environmental footprint of conferences and workshops. These criteria, which will apply to future scientific conferences, were already put into practice at the World Biodiversity Forum in Davos in February 2020.

Researchers from ETH Zurich organised the second edition of CYBATHLON in 2020. This is a unique competition for people with disabilities who, supported by state-of-the-art technical assistance systems, compete against each other to solve tasks that are relevant to their daily lives. This year, the event took place in a new format due to the coronavirus pandemic. Teams from a total of twenty nations took part in front of a global audience.

The external locations of the two Federal Institutes of Technology also play a major role in the international reputation of the ETH Domain. ETH Zurich's Singapore-ETH Centre (SEC) celebrated its 10th anniversary in 2020. Founded in partnership with the National Research Foundation in Singapore, the centre examines certain aspects of urbanisation. The newest programme was launched by ETH Zurich in the spring of 2020 on the



Do you speak quantum? RETHINKING CREATIVITY Exhibition in the ETH Zurich Pavilion at WEF 2020 in Davos.
› Andreas Eggenberger/ ETH Zurich

topic of Future Health Technologies with various partners from universities, hospitals and industry in Singapore. The EPFL Middle East campus in Ras Al Khaimah (United Arab Emirates) continued its activities in 2020. A total of 22 students completed their Master's degree in Energy Management and Sustainability (MES) there. The pandemic has unfortunately postponed the discussions initiated in 2019 on the long-term extension of the partnership between EPFL and the government of Ras Al Khaimah. If no decision is taken to extend the programme, all activities will be suspended in the autumn of 2021 (see also p. 9).

Active role in the framework of the bilateral cooperation with emerging economies

ETH Zurich is the leading house commissioned by SERI to coordinate Switzerland's bilateral research cooperation with China, South Korea, Japan and the ASEAN region (Association of Southeast Asian Nations). In 2020, within the scope of this mandate, ETH Zurich launched a total of five project cycles and a special call for COVID-19 projects, which attracted keen interest in the scientific community. Also in Asia, WSL entered into a scientific cooperation agreement with the Institute of Tibetan Plateau Research (ITP) of the Chinese Academy of Sciences. The project is funded by SNF under its Sino-Swiss Science and Technology Cooperation Joint Research Projects programme. The aim is to investigate the causes of the different retreat rates of glaciers in different climate regions. The institutions of the ETH Domain are also involved in numerous other regions of the world, and in particular in Africa. The ETH for Development (ETH4D) initiative, launched in 2019, developed rapidly in 2020. In particular, a Master's degree programme in Mechatronics Engineering was launched in Ghana, which was developed in close cooperation with Ashesi University and partners from Swiss industry.

At EPFL, the Excellence in Africa (EXAF) centre, which was newly created in 2019, conducted the first calls for collaboration projects between young African and EPFL professors this year. From the 200 applications received, 19 tandems were formed with EPFL professors. The institutions of the ETH Domain also got involved in the Middle East and North Africa (MENA) region in projects such as the establishment of the Transnational Red Sea Research Center by EPFL and the participation of the PSI in the construction of the SESAME synchrotron (Synchrotron-light for Experimental Science and Applications in the Middle East) in Jordan. Empa is involved in the Sustainable Recycling Industries project which is funded by the Swiss Agency for Development and Cooperation (SDC). In this context, Empa supports state organisations, associations and companies in South America and Africa in the development and operation of sustainable recycling systems for electronic waste. Eawag is also involved in research activities in developing countries. As part of its Eawag Partnership Programme for Developing Countries (EPP), it awards six fellowships a year to students from developing countries. The programme was evaluated in 2020 and received very good feedback from the 66 fellowship recipients who participated from 2008 to 2019.

Strategic objective

ROLE IN SOCIETY AND NATIONAL TASKS

With innovative educational formats, the institutions of the ETH Domain succeeded in maintaining a dialogue with the population in 2020. Cooperation with teachers and schools, in order to improve computer science lessons, was again of great importance. In view of the coronavirus pandemic, experts from the ETH Domain advised representatives from politics and administration from a scientific perspective to support them in their decision-making.

Dialogue with society

The institutions of the ETH Domain maintain a diverse exchange of ideas with the public. Thanks to the switch to digital or hybrid forms of communication, they also succeeded in reaching their target audience in 2020. For example, the autumn programme of ETH Zurich's "Treffpunkt Science City" entitled "Es wird heiss" (it's going to be hot), was offered online for adults, while children and young people attended lessons in ETH Zurich's main building, grappling with issues relating to the climate crisis. The PSI organised guided tours of the SwissFEL and the Energy System Integration (ESI) Platform via live video streams and plans to maintain this format as a supplement to the traditional visitor programmes in the future. EPFL also opted for a live-stream at this year's edition of its "Ma thèse en 180 secondes" (My Thesis in 180 Seconds) competition, where doctoral students present their work in simple and understandable language. In addition, numerous scientific facts were made available to the public by the institutions of the ETH Domain in a way that made the time and location of access irrelevant. Eawag produced fact sheets and FAQs on current topics such as microplastics or plant protection products in water. Empa launched a series of NEST podcasts, consisting of conversations with representatives from the construction and architecture sectors. With a special edition of the Swiss Forestry Journal, WSL succeeded in making its research results on extreme drought available in the summer of 2018 in an attractive form for forest experts. The PSI provided a decision-making aid for buying a car in the form of the carculator. In the Web tool, a life cycle assessment is performed on the vehicles and in addition to the greenhouse gases, other factors such as emissions of particulate matter are also included. The dialogue with society also includes the participation of the population in scientific projects (citizen science). Led by WSL, around 250 volunteers helped to record all plant species that grow wild in the canton of Zurich over a period of eight years. A book with more than 1,000 pages is the crowning glory of this citizen science project.

The institutions of the ETH Domain bear a special responsibility when it comes to advising authorities and political decision-makers in the context of current issues. In the reporting period, experts from the ETH Domain were available to the public and the media, in particular with regard to questions relating to the coronavirus pandemic. Within the framework of the Swiss National COVID-19 Science Task Force, which was mandated by the Federal Government and has been headed by Professor Martin Ackermann (ETH Zurich/Eawag) since August 2020, they assisted politicians and administration staff in their decision-making by providing them with scientific findings (see also p. 12 ff.). In addition, for example, researchers from the Eawag spin-off Ranas, Eawag and ETH Zurich conducted a joint

As part of the Pro Juventute Ferienpass courses, children go on an expedition where they are given a special insight into the profession of snow and avalanche researcher.
› Cornelia Accola/SLF

study to determine whether and how well the population adheres to the behavioural recommendations for protection against COVID-19 viruses. The results can be used to optimise campaigns. With various initiatives, the ETH Domain also directly supported the hospitals in the fight against the COVID-19 virus. At the end of March, for example, urgently needed face shields were produced in a student workshop at ETH Zurich and later brought to industrial-scale production. Empa developed safety standards for textile masks, in order to contribute to the creation of domestic production capacities for "community masks". In the context of the Switzerland-wide Innosuisse project ReMask, it also conducted joint research with ETH Zurich and EPFL to develop new mask types and components. Students set up the Students4Hospitals Internet platform which allowed 20 healthcare providers to recruit volunteers within a few hours. The two Federal Institutes of Technology coordinated urgently needed laboratory materials with the Academic Resources for COVID platform.

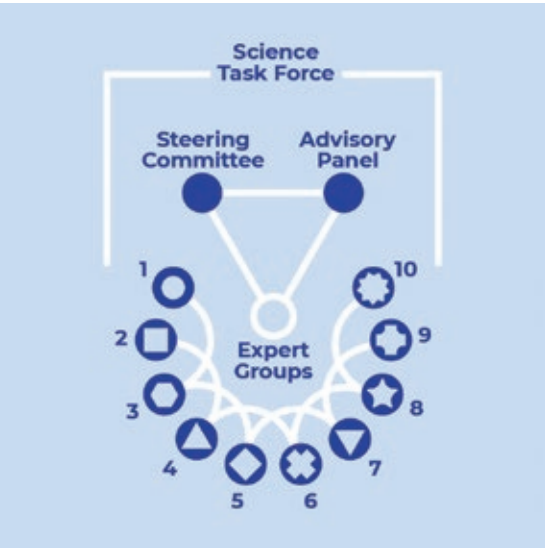
In addition to the coronavirus pandemic, biodiversity, climate change and energy were other important topics where the institutions of the ETH Domain contributed to the decision-making process in the reporting period. Researchers from WSL and the Swiss Biodiversity Forum of the Swiss Academy of Sciences showed in a study that biodiversity is also damaged by more than 160 types of subsidies, such as the earmarking of traffic taxes for a specific purpose or the promotion of small-scale hydropower stations. WSL also published a comprehensive summary of how the use of forests can be reconciled with the protection of biodiversity. Around a hundred research institutions and companies from all over Europe were involved in this book project. Researchers at the PSI worked with British economists to develop a method for tracking changes in energy prices, both in retrospect and modelling them in future scenarios. Their studies clearly showed that increases in energy prices only have an effect on energy consumption in the long term. A study conducted by Empa in collaboration with researchers from the University of Zurich showed that a 5G network can reduce greenhouse gas emissions by making new applications possible and by implementing digitisation more efficiently. Finally, in the context of sustainable development, the institutions of the ETH Domain are also aware of their own role model status (see Objective 9, p. 75 ff.).

Commitment to STEM subjects

The institutions of the ETH Domain offer a wide range of programmes to nurture young people's interest in science, technology, engineering and mathematics (STEM). Of particular importance is the cooperation with the schools. In the reporting period, ETH Zurich laid the foundations for the ETH Youth Academy. With its range of services in the STEM area, the Academy is also specifically aimed at pupils who have not yet chosen their baccalaureate profile. In addition, the new "Lern mit mir" (learn with me) platform offers apprentices at ETH Zurich easy-to-access support, especially relating to STEM topics. In 2020, EPFL expanded its range of "Semaines pré-universitaires" services (Pre-university weeks) for baccalaureate school students in the fields of mathematics and physics. In addition, the "Cours de mathématiques spéciales (preparatory year CMS)", which was originally intended only for persons without the relevant necessary qualifications, was opened up to baccalaureate students. At the beginning of the year, PSI researchers were able to introduce the im-

portance of European research infrastructure to pupils of the cantonal school in Wohlen, based on the problem of the distribution of particulate matter and aerosols in the air. The WSL Institute for Snow and Avalanche Research SLF gave children from the Davos region a special insight into the snow and avalanche researcher profession in the form of an excursion from Gotschnagrat to Schatzalp within the framework of the Pro Juventute "Ferienpass" (holiday pass) courses. Thanks to the SMARTFELD educational initiative of the St.Gallen University of Teacher Education, which Empa is involved in, hundreds of students were able to acquire programming knowledge in the reporting period.

The corresponding training and further education of the teachers is closely linked to the promotion of STEM topics. One of the main priorities here is still to improve computer science lessons. The Training and Advisory Centre for Computer Science Teaching (ABZ) at ETH Zurich supports schools and teachers who want to develop or expand their computer science teaching skills. In the reporting period, more than 200 teachers completed the various further education courses, and around 120 student teachers were taught computer science by the ABZ together with PH Graubünden (university of teacher education). The four-volume ABZ teaching tool "einfach INFORMATIK 5/6" (Simply Computer Science 5/6) won the prestigious Worlddidac Award 2020. At EPFL, the Center for Learning Sciences (LEARN) deals with the issue of digital education. On behalf of the canton of Vaud, it is currently conducting pilot tests at 12 schools with lessons on various aspects of computer science. More than 600 teachers were trained to do this. In addition, the centre has also been involved in the roteco.ch platform, for example, which aims to promote the use of robotics in schools and which mint & pepper from the Wyss Zurich centre of ETH Zurich and the University of Zurich is involved in, amongst other things. The further development of the "Thymio" robot at EPFL and the development of new MOOCs for its use also play an important role at Roteco.



The Swiss National COVID-19 Science Task Force advises the authorities during the current COVID-19 pandemic.
› 1kilo

National tasks

On behalf of politics and in the interest of society, the institutions of the ETH Domain carry out a variety of national tasks, research-based services and the operation of unique facilities in Switzerland. Eawag and EPFL house the Swiss Centre for Applied Ecotoxicology. In 2020, the quality criteria for various pesticides and pharmaceuticals developed by the Ecotox Centre were incorporated into the Swiss Waters Protection Ordinance and are now considered limits for surface waters. As part of a new industrial project in the reporting period, the centre, together with Eawag and EPFL, studied, among other things, the bioavailability and toxicity of tyre abrasion. A new measuring station of the National Air Pollution Monitoring Network (NABEL) was recently installed next to the Eawag experimental ponds in Dübendorf. This replaces the previous 30-year-old building which had to make way for a new Empa building. The NABEL, which is jointly run by Empa and the Federal Office for the Environment (FOEN), provides an overview of air quality in Switzerland. Thanks to a porthole, the new measuring station is the only one in Switzerland to provide the public with an insight into its inner workings. WSL also cooperates with FOEN on the Swiss National Forest Inventory (NFI). The results report of the summer of 2020 on the fourth inventory of the Swiss forest shows that, despite factors such as insect infestation and diseases, it is in good condition in principle (see p. 28). The PSI ensured the full, unrestricted operation of its Center for Proton Therapy despite the coronavirus pandemic. Unfortunately, patient referrals – as was the case in similar facilities throughout Europe – declined significantly in this phase, which is likely to negatively impact cancer mortality rates. In parallel with patient operations, the world's first FLASH irradiation with protons was tested – a possible new method for particularly fast and high-dose tumour therapy. Finally, ETH Zurich adopted a new strategy for the university's collections and archives, in order to preserve public cultural assets for a long time. The focus is also increasingly on dialogue with the public and digital change where this is concerned.

Strategic objective

SOURCES OF FINANCING AND ALLOCATION OF FUNDS

The total federal contribution of the Federal Government provided solid financing for the ETH Domain in the reporting year. Revenue from third-party funding was maintained in 2020. The responsible management of resources in the past, as well as the stable financing base at a good level, allowed us to react flexibly and appropriately to the challenges brought by the coronavirus pandemic as well as to developments in teaching and research.

Development of third-party funds

In the reporting period, the total federal contribution[1] amounted to CHF 2,596m, and revenue from third-party funding amounted to CHF 1,080m. Their share of the total sum of CHF 3,676m was 29% and is thus at the level of previous years. Conversely, around 71% of the funding is directly provided by the Federal Government.

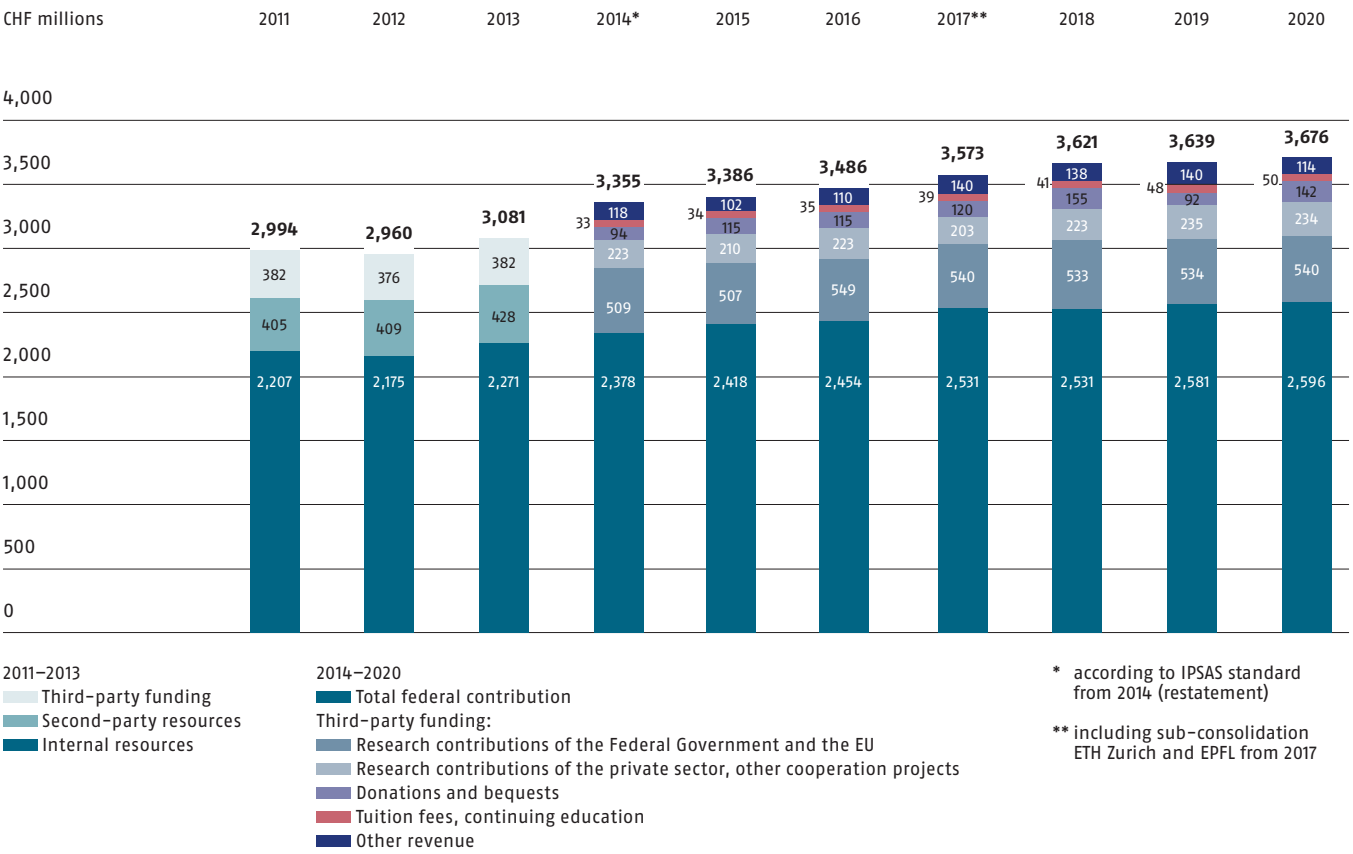
The diversification of funding sources and responsible, economical management of the funding are of central importance for the ETH Domain. A long-term comparison shows that the share of third-party funding has gradually increased (see Fig. 1, p. 72). This development corresponds to the strategic objectives set by the Federal Council. It should continue to be pursued in the future, without jeopardising the freedom of teaching and research in the initiation of new projects. In view of the increasingly fierce international competition in the university environment with technology-intensive top-level research and the continual rise in the number of students, the broadening of the funding base for the ETH Domain is both a necessity and an increasing challenge.

The development of third-party funding in 2020 shows a positive overall picture in spite of the challenging situation relating to the coronavirus pandemic. Compared with the previous year, revenue from third-party funds increased by CHF 21m (previous year: CHF 1,059m). The reason lies in the gratifyingly high income from donations, while income from research projects remained at the previous year's good level. Other income, on the other hand, declined significantly, reflecting the effects of the coronavirus pandemic. Nevertheless, the budget of CHF 1,043m was exceeded, mainly because of the income from donations and bequests, which was higher than planned.

The fight against COVID-19 mobilised researchers even more in 2020: the ETH Domain has launched a significant number of research projects which are financed with research funding, funding from the business sector, but also substantially with its own funds. In addition, the experts involved were on the Swiss National COVID-19 Science Task Force where they were available to advise the Federal Government and the Swiss population with their know-how. In addition, donations of more than CHF 13m have been earmarked for researching the SARS-CoV-2 virus.

[1] In this case, the total federal contribution of the Federal Government is meant from the point of view of the expenditure ceiling. It consists of the financing contribution or operating credit (CHF 2,355m) and the investment credit (CHF 241m).

Fig. 1: Development of the sources of funding



In 2020, more than two thirds of third-party funding comes from competitive research funding projects at national and European level. Significant revenue comes from national research funding (the Swiss National Science Foundation SNSF and Innosuisse: CHF 314m, previous year: CHF 309m) and European Union Framework Programmes for Research (EU FPs) (Horizon 2020, ERC Grants: CHF 146m, previous year: CHF 152m). Other significant sources of funding are from cooperation with the business sector (CHF 136m, previous year: CHF 146m), research funding for projects from the Federal Government (policy research: CHF 80m, previous year: CHF 82m) and the cooperation projects with the cantons, communes and various international organisations (CHF 98m, previous year: CHF 90m). The shifts in relative importance between the donors show the dependence on the announced research priorities.

Donations and bequests are also part of the revenue from third-party funding (CHF 142m, previous year: CHF 92m), as well as tuition fees and revenue from continuing education courses (CHF 50m, previous year: CHF 48m) and the various service revenues (other revenue: CHF 114m, previous year: CHF 140m).

The indirect costs from third-party funded projects are offset in such a way that the base budget is not jeopardised by these costs.

When making an overall assessment of the development of third-party funding, it is also necessary to take balance sheet transactions into account, in particular the development of dedicated third-party funds from contracts recognised in accordance with IPSAS 23. They indicate the inventories of project commitments for which services are still to be provided in the following years. The dedicated third-party funds entered in the balance sheet rose in the reporting period (CHF 1,608m, previous year: CHF 1,555m). This higher volume will in future have an effect on the research contributions as higher revenue and indicates that the required expansion of the funding base remains achievable.

A further significant criterion for assessing whether Objective 8 has been achieved is the development of funding (SNSF, Innosuisse and EU FPs). It increased by 6% compared to the previous year (2020: CHF 468m, 2019: CHF 443m; 2018: CHF 512m; 2017: CHF 422m), especially in the case of commitments from the EU FPs as well as Innosuisse.

Maintaining teaching and research freedom

The two Federal Institutes of Technology and the four research institutes ensure that the research results of third-party funded projects can be published. They thus guarantee the unrestricted freedom of teaching and research. The publication freedom of and with

supported people and projects is also guaranteed at all times.

Research freedom and the right to use research results are enshrined in the strategy for knowledge and technology transfer and in internal directives and are regulated and respected in the research contracts with the donors. In addition, the handling of donations is regulated explicitly by the code of conduct.

Increase in efficiency and use of synergy effects
Joint initiatives and use of research infrastructures result in significant synergy effects. These include projects such as the Strategic Focus Areas (SFA), the "Blue-Green Biodiversity" project jointly initiated by WSL and Eawag, and the collaboration between Empa and ETH Zurich which commenced in 2020 on openBIS, a laboratory information management system and the Moodle learning platform. Other current examples are the Swiss Data Science Center (SDSC) of EPFL and ETH Zurich, the Energy System Integration (ESI) Platform of the PSI, Empa, EPFL and ETH Zurich and the shared libraries. The joint EPFL and Empa Laboratory of Materials for Renewable Energy (LMER) is used to conduct research on the EPFL Valais Wallis site.

In addition, the research institutions are using the joint financial platform SAP4Four, which they upgraded in 2020 with new functions. The reporting platform on SAP FC is used in a cross-departmental manner. In order to ensure an efficient operation, ETH Zurich is also pooling liquidity for the entire ETH Domain. Coordinated procurement within the ETH Domain (KoBe ETH+) and with the University of Zurich achieves significant savings.

ETH Zurich and EPFL achieve a similar synergy effect with different platforms that researchers use together within the institution. By pooling the equipment, the investments are optimised on the one hand and higher utilisation rates are achieved on the other hand. In addition, specifically trained internal teams reduce operating and maintenance costs. The effectiveness of the resources and finance platform introduced at ETH Zurich in the previous year has been confirmed. The new system enables more holistic management of funds at all management levels and passed the emergency operations test during the coronavirus pandemic. The digitisation of administrative processes, which has been promoted in the past, has also proved valuable. Due to the digitised processing of invoices and payments, for example, ETH Zurich proved to be a reliable partner during the challenging situation.

Allocation of funds based on relevant criteria
The ETH Board allocates federal funds (total federal contribution) in accordance with Section 33*a* ETH Act. The allocation of funding within the ETH Domain is governed by Section 12(2) of the Ordinance for the ETH Domain. The Federal Council's strategic objectives for the ETH Domain, which are tailored to the corresponding expenditure ceiling, form the basis for the ETH Board's target agreements with the institutions. When making these annual allocations of funding to the institutions, the ETH Board draws upon the budget requests of the institutions and the assessment of their performance. The funding effectively available to the ETH Board (budgetary credits) are then decided by the Parliament in December. Any changes in the funding available are taken into account when allocating funds in March of the following year.

The budget growth requested by the institutions of the ETH Domain for 2020 was higher than the federal funding available in March 2019. Based on the following principles for the allocation of funds in 2020, the ETH Board decided to cover the expenditure surplus from the reserves of the ETH Board:

- targeted support for strategic projects and initiatives to further strengthen cooperation in the ETH Domain; a moderate increase in support for strategic projects at institutional level.
- Taking into account the additional burdens on the two Federal Institutes of Technology as a result of the continuing student growth; support for measures initiated and planned for the long-term stability and structural development of the institutions.
- Appropriate consideration of the institutions' performance in the allocation of funds.

The Federal Assembly has approved a total of CHF 2,596m for the 2020 budget of the ETH Domain (including an increase of CHF 30m, FedD Ia of 12 December 2019).

The ETH Board allocated the funds for the base budget (total of CHF 2,442m) as follows:

- ETH Zurich CHF 1,258m
- EPFL CHF 663m
- PSI CHF 296m
- WSL CHF 58m
- Empa CHF 106m
- Eawag CHF 62m

Funding for the strategic projects of the ETH Domain:

- Research infrastructures / large-scale research projects: CHF 64m
- Strategic focus areas (SFA): CHF 25m
- Digitisation in the ERI Area: CHF 15m
- Incentive and initial funding, other central and various expenses, as well as special funds: CHF 45m

Funding for the ETH Board:

- Own consumption by the Administration of the ETH Board and Internal Appeals Commission: CHF 15m

The resulting over-budgeting of CHF 9m from the 2020 allocation of funding is covered by the free reserves of the ETH Board.

Dismantling and disposal of the PSI accelerator plants

Radioactive waste arises from the use of nuclear energy and ionising radiation applications in medicine, industry and research (MIR waste). The Nuclear Energy Act and the Radiation Protection Act set out the requirements for disposal. The financing of the provision for the decommissioning of the PSI accelerator plants (CHF 542m) will be provided by means of annual savings which will be added to the financing contribution. By the end of 2020, the savings amounted to a total of CHF 42m (savings amount in 2020: CHF 11m). The PSI has so far used around CHF 5m (2020: CHF 1m) of the accrued savings for initial measures in connection with the dismantling.

Risk management

To that end, we refer to the report on the risk situation and risk management, p. 48.

Fig. 2: Allocation of funding to the institutions of the ETH Domain (after taking into account the reallocation in credit/funds within 2020)

						Δ 2019 / 2020	
CHF millions	2016	2017	2018	2019	2020	abs.	%
ETH Domain [1, 2, 8, 9]	**2,453.8**	**2,530.8**	**2,530.9**	**2,581.2**	**2,596.1**	**15.0**	**0.6**
ETH Zurich [3]	1,247.2	1,297.4	1,300.5	1,298.1	1,314.9	16.9	1.3
EPFL [4]	640.3	666.2	664.9	664.8	698.4	33.6	5.1
PSI [5, 7]	305.4	294.3	307.3	309.8	315.1	5.3	1.7
WSL	55.9	58.7	58.3	57.7	59.4	1.7	2.9
Empa	110.7	114.7	105.2	115.7	114.8	−0.8	−0.7
Eawag	59.1	61.5	61.5	60.5	62.2	1.7	2.8
ETH Board [6]	35.1	38.2	33.2	74.7	31.3	−43.4	−58.1

Additional information on the budget/financial statements 2020:

1 Total allocation of funds in 2020

2 Annual tranches in accordance with the approved expenditure ceiling for 2017–2020 (credits taking into account the expenditure ceiling of the ETH Domain): annual tranche for 2020: CHF 2,643m/Federal Decree (FedD) on the budget according to FedD Ia for 2020: CHF 2,596m

3 Including sustained scientific user lab for simulation based science at the CSCS: CHF 23m, start-up funding President: CHF 3m, additional costs: Serious earthquake measurement network: CHF 1m, streamlining of the real estate portfolio: CHF 10m

4 Including the neuro information technology project, the Blue Brain Project: CHF 21m, start-up funding President: CHF 3m

5 Including ATHOS/SwissFEL: CHF 13m, Action Plan Energy PSI: CHF 4m, start-up funding Director: CHF 5m

6 Including strategic projects, financing the dismantling of accelerator systems at the PSI (CHF 11m); previous year 2019: including funds received in 2019, which were used to cover the expenditure surplus budget 2020

7 Including special funds (CHF 5m)

8 Including strategic focus areas (Personalized Health and Related Technologies, Data Science, Advanced Manufacturing): CHF 25m, action plan for digitisation in the area of ERI: CHF 15m

9 Including research infrastructure (upgrade to CMS detectors at CERN, Swiss Plasma Center) (total: CHF 7m)

Strategic objective

REAL ESTATE MANAGEMENT

The year 2020 was expected to be a year of consolidation in real estate management. Instead, due to the coronavirus pandemic, it was not clear for long periods whether the current construction sites could be kept open and the plans and projects continued as planned. The management of the budgeted funds was difficult, as both delays and significant acceleration of various processes had to be dealt with.

Strategy and long-term portfolio development
In 2020, the ETH Domain developed its long-term planning for the real estate portfolio. It did so in close coordination with the academic strategy processes of the institutions for the performance period from 2021 to 2024. The challenge was to describe the major structural and spatial developments and measures, as well as the financial requirements for the next four to twelve years. The resulting "Räumliche und finanzielle Gesamtkonzepte" (RFGK) (spatial and financial master plans SFMP) for 2021 to 2032 implement the requirements of the Federal Government as the owner of the real estate. These specifications come from the Federal Council's strategic objectives, the climate package, the structural reforms and its role as a model for sustainable building. Topics include, among others, maximising the use of existing building spaces by developing flexible workplace plans, such as multi-space and desk-sharing for office use. In addition, the SFMP show how the preservation of value and functionality are to be ensured and the necessary new infrastructures for teaching and research are to be provided and financed. This is in view of the fact that due to the high financial commitment of the Federal Government to absorb the consequences of the pandemic, the future scope of the financing of the ETH Domain – and thus its structural investments – is uncertain. The ETH Board is expected to discuss the SFMP in March 2021.

The consequences and effects of the coronavirus pandemic and the protective measures taken by the ETH Domain on the real estate portfolio, for example on the usability of existing areas and the amount of space needed in the future, cannot yet be predicted. The emergency mode had led to significant changes in the ETH Domain, at least temporarily: working from home or online lectures were concepts that were applied immediately and successfully in early 2020, even though they were still in the development stage. It remains to be seen what the occupational health and social consequences will be.

To relieve the burden on the Zentrum campus, **ETH Zurich** transferred around 550 workplaces to the leased Octavo building in Oerlikon: open-plan, multi-space offices (with an open-space layout) enable new forms of collaboration here. The real estate management of ETH Zurich will draw conclusions on further outsourcing or concentration of workplaces based on this pilot project. A decisive step has been taken towards realising the vision for the ETH Campus Hönggerberg by 2040. The Municipal Council of the City of Zurich has approved the planning principles for the future development of the campus. Thus, the process in which ETH Zurich and the city and canton of Zurich worked together to develop the necessary planning principles is expected to be completed in 2021 after around five years.

EPFL's real estate strategy ensures the preservation of value and functionality of the first and second stages of the project to extend buildings dating from the 1970s and 1980s, and worked on the planning in 2020 to meet the ever-increasing demand for state-of-the-art infrastructure, for example for physics and chemistry. The main focus is on the renovation and densification of the Ecublens campus, as well as the expansion of activities in the surrounding cantons, in particular Valais, Fribourg and Geneva. The EPFL–UNIL Hautes Ecoles Master Plan was approved by the competent bodies of the two universities at the beginning of 2020 and should enable constructive approaches to be implemented with the neighbouring communes and the canton of Vaud for the conversion of part of the neighbouring site to the north (previously sports fields). By setting up Discovery Learning Laboratories (DLL), spaces

are being created in which practical work is taught thematically and interdisciplinary cooperation is encouraged.

The PARK innovAARE, which is next to the **PSI** site and is financed by private investors, is taking shape. The PSI will rent spaces in the PARK innovAARE to allow the spatial consolidation of individual areas as well as conversions of, or structural and energy efficiency improvements to, existing buildings on the PSI site. These considerations will then be integrated into the development of the PSI Campus 2030 master plan. With new replacement buildings, **WSL** is creating additional spaces, e. g. in Davos for the new Climate Change, Extremes, and Natural Hazards in Alpine Regions Research Center (CERC) or with the planned replacement of the workshop building in Birmensdorf. **Empa** and **Eawag** have a continuing need for additional laboratory and office spaces on the joint site in Dübendorf. Empa's building stock still reflects the original mission as a national testing centre. The joint construction project "Master Plan Research Campus Empa Eawag" in Dübendorf continues the structural transformation into a research institute.

In 2020, the ETH Board carried out several real estate transactions to implement the strategies and long-term planning. For example, it acquired a hotel property for ETH Zurich through a barter deal, which will be used as accommodation for visiting students in the coming years. The plot is part of the development perimeter in the densely used Hochschulgebiet Zürich Zentrum (Central Zurich University Area) (HGZZ) and is therefore of great importance as a strategic reserve for additional teaching and research spaces.

Real estate management in figures

The purchase value of the ETH Domain's real estate portfolio at the end of 2020 amounted to CHF 8.11bn. In terms of value, this represents about one third of the entire real estate portfolio of the Federal Government. The book value is around CHF 4.13bn. The ETH Domain uses around 400 buildings on 125 plots of land. The main usable area reported at the end of 2020, which covers 1,003,000 m^2 is up 1.7% compared to 2019.

The mix of space (see Fig. 26, p. 100) with state-owned buildings for own use and use by others, and buildings rented by third parties (in m^2 of main usable area since 2011) shows how some of the growth in recent years could only be covered using additional leased space. The growth in leased space is attributable to the changes in the statistical allocation of space after 2013. Without this effect, there would be a steady decrease in the leased space.

Ongoing and completed projects of 2020

After the number of professorships at both universities and the need for state-of-the-art infrastructure increased further in 2020, demand for new buildings, extensions and repairs remains consistently high. In 2020, numerous important new projects were launched to maintain value and functionality. Refurbishments are being carried out with a view towards improving use, operating costs, energy status, disabled access and earthquake safety, amongst other things.

With the new special building regulations for the Hönggerberg campus, **ETH Zurich** will be given the opportunity to optimise the utilisation of the plot. Work on the complete renovation and extension of the HIF (D-BAUG) building was also continued there; the plans to build the new HPQ physics building were also further developed and third-party funds were successfully obtained for this purpose. In addition, the university was able to complete the building envelope of the new GLC research building on the Zentrum campus, which provides laboratory and office spaces in Gloriastrasse for the departments of D-HEST and D-ITET, and to push ahead with the interior design. In addition, the refurbishment of the main building HG and the refurbishment and extension of the ML/FHK Machine Laboratory progressed as planned. The topping-out ceremony for the BSS for Biosystems new build project in Basel (image) took place in the second quarter of 2020. **EPFL** continued to modernise the CCT heating plant with an enlarged data centre and the expansion of the lake water pumping station. In addition, it opened the DLL EL Engineering building.

The **PSI** was able to prepare the surfaces for three of the planned experimental stations on the ARAMIS and ATHOS beamlines as part of the expansion of the SwissFEL. In addition, the planning of the construction of a new laboratory began with the pre-qualification as part of a planner election process. A feasibility study was developed for the replacement of the daycare centre with the new build. In Davos, **WSL** was able to begin work on a replacement new build. On their Dübendorf site, **Empa** and **Eawag** submitted the planning application for the research campus master plan in June; planning permission is expected to be granted in January 2021. The heat pump was commissioned in 2020 for the new medium-temperature district heating network for the supply of the site, which was completed in 2019. This will be supplemented in 2021 with a combined heat and power station. **Eawag** finished building the new FLUX laboratory building on the Dübendorf site in December and started the commissioning process; the handover to the building owner is planned for the second quarter of 2021. There are plans to replace the existing barn on the Kastanienbaum site with a new build housing office, laboratory and storage spaces (Limnion project). Planning application for this was submitted at the end of 2020.

Investments and source of funds in 2020

The investment credit for buildings in the ETH Domain in 2020 was CHF 271.03m following a credit reallocation from the financial contribution of CHF 36m (20%), an

New BSS building in Basel: a complex construction site in an urban environment.

With the conscious decision to pursue a subtle and sustainable urban development addition, the new building is oriented towards the neighbouring University Children's Hospital Basel (UKBB) and a six-storey atrium building is being created for an open, interdisciplinary and academic exchange of ideas.
› Erich Meyer

amendment of CHF 24m (amendment IIb Coronavirus Dispatch; 13.3%) and the release of dedicated reserves of CHF 30m for the BSS new building project in Basel. This meant that it was well above the previous year's value (CHF 218.6m). The reasons for this were rapid construction progress on large projects, rapid refurbishments as a result of empty offices and laboratories (due to the coronavirus pandemic) and additional available capacities at companies.

Some 50.6% of the investments were accounted for by new buildings, and 49.4% by preserving value and functionality. No third-party funds were used for federal real estate (co-financing). CHF 125.1m was used from the Federal Government's financial contributions for investments in user-specific operating facilities which will be owned by the institutions. These investments were supplemented by third-party funding of CHF 12,6m. The total volume of construction authorised by the ETH Domain in 2020 amounted to CHF 408.8m (see Fig. 28, p. 101). The ETH Domain received an accommodation loan of CHF 244.4m in 2020 for the calculated rent on the state-owned real estate. The Source of Funds chart (see Fig. 23, p. 99) shows the sources of funds for the buildings in the ETH Domain since 2011. The annual fluctuations are dependent on the type of grant and the scope of the current construction projects.

Construction programme for 2020:
Major ETH Domain projects

In the case of new construction projects planned in the context of new builds, extensions or refurbishments, the ETH Domain applied for the necessary contingent credit with its annual construction programme. The 2021 construction programme for a total of CHF 298.5m (total credit), approved by the Federal Parliament on 16 December 2020, includes the following four major projects: An application has been made for a contingent credit of CHF 73.5m for the realisation of the first new builds in accordance with the Master Plan Research Campus Empa Eawag in Dübendorf. This will enable the increased demands placed on the shared site with regard to usable laboratory space, technical infrastructure and exterior space design, including a transport and logistics concept, to be met. Another major construction project costing CHF 18.1m is the refurbishment and reconstruction of the HPT office, laboratory and workshop of ETH Zurich (Hönggerberg campus). In addition, ETH Zurich applied for a contingent credit of CHF 11.1m for the renovation of the covered car park and the forecourt of the main building HG (on its Zentrum campus). The PSI has applied for CHF 14.6m for the Swiss Federal Interim Storage Facility BZL 2 ORAB. A credit line of CHF 181.2m has been requested for 2021. Credit lines make it possible to carry out construction projects costing up to CHF 10m, and to plan projects over CHF 10m.

Maintaining value and functionality

The ETH Board is legally obliged to maintain the value and functionality of the properties of the ETH Domain, and this is in the interests of the Federal Government as the owner of the real estate and of the ETH Domain as the user. The state of the individual properties will be determined applying standard methodology, will be accumulated at portfolio level and will be compared against multi-year trends. Despite the advanced age of some of the buildings and their intensive use, the state value of around 82% determined in 2020 remains constantly high in relation to the new value (see Fig. 24, p. 99). The refurbishment work on the historical building stock is considerable in some cases, leading to challenging projects. Renovation projects in excess of CHF 561m are currently included in the 2021 to 2024 real estate investment plan. They triggered an

investment volume of some CHF 134m in 2020. In addition, ongoing maintenance work amounting to some CHF 50m was funded from the state financial contribution. Consequently, the ETH Domain demonstrated that it is using the building stock provided by the Federal Government responsibly and sustainably.

Coordination tasks
In 2020, the Real Estate department of the ETH Board coordinated the interests of the institutions of the ETH Domain with those of the government agencies in the development of norms, standards and guidelines for the planning, realisation and operation of real estate. With the participation of the institutions, the focus was on the issues of structural reforms, such as the development of a concept for desk-sharing, a strategy for digitisation in the construction sector (BIM method) and a control system for the economic use of space. Preparations for the entry into force of the revised procurement law with the new contract awarding culture was another focal point. In the field of sustainability, the Real Estate department not only played a coordinating role, but it also played a role in shaping various work groups on topics such as building culture, life-cycle costs, energy and the environment (pursuant to the Exemplary Energy and Climate initiative, EEC). The ETH Board is also a member of the commission of the Office for University Buildings (Fachstelle für Hochschulbauten, FHB) for the University Council of the Swiss University Conference. This involves determining the Federal Government's building investment and building use contributions.

Governance
In December 2020, the ETH Board decided to impose minimum standards for the management of construction projects in the ETH Domain. In doing so, it implemented recommendations and suggestions for improvements from the Swiss Federal Audit Office (SFAO), for example relating to the large-scale BSS Basel projects of ETH Zurich and the EPFL's heating system/data centre. A standard process for real estate projects, the standardisation of control instruments, as well as approval and reporting, are to further increase the quality of construction projects and simplify cooperation.

In 2020, the staff of the ETH Board, together with the six institutions, prepared the periodic reports on risk management and the internal control system (ICS) in real estate management. Initial findings from the coronavirus pandemic were also taken into account during this process. The associated improvement process and the measures introduced prove a careful handling of the Federal Government's real estate that has been made available for use.

After intensive discussions, the ETH Board concluded the audit mandate issued by the Federal Council for the possible transfer of ownership of the Federal Government's real estate to the ETH Domain. On the basis of several expert opinions and the negative attitude of the institutions, he has informed the owner that, in its view, no significant advantages can be achieved with a transfer of ownership.

Due to the cancellation of major events due to the coronavirus pandemic, the result of the SwissTech Convention Center (STCC) deteriorated further in 2020. Therefore, on behalf of the ETH Board, EPFL is seeking solutions with the investor to improve the financial prospects in the long term. The results are expected to be available by the end of 2021.

Environment and energy

Environment and energy in the context of sustainability
In 2019, the Federal Council decided with the Federal Administration's Climate Package (Klimapacket Bundesverwaltung) that the Federal Administration should become climate-neutral by 2030. The Federal Government intends to act as a role model in the sustainable and efficient use of energy. As a building and real estate body (BLO), in 2020 the ETH Board, in close coordination with the institutions of the ETH Domain and together with the Federal Office for Buildings and Logistics (FOBL), armasuisse Real Estate and the Federal Roads Office (FEDRO), defined the measures for the real estate portfolio with which it intends to achieve the Federal Council's objectives.

Strategic real estate management in the ETH Domain

Efficient building infrastructure is a central requirement for enabling both Federal Institutes of Technology and the four research institutes to achieve their targets in teaching and research and to meet the required quality standards. The real estate of the ETH Domain is owned by the Federal Government. The investment credit for construction is separated annually in the budget for a specific purpose. It appears in the state accounts under the Federal Department of Finance (Federal Office for Buildings and Logistics, FBL). As one of the Federal Government's three building and real estate authorities, the ETH Board assumes the ownership role in trust. It is responsible for the real estate portfolio of the ETH Domain and consults the institutions on strategic real estate management in order to ensure the functionality of the real estate portfolio in the medium and long term and to preserve its cultural value.

Needs-based planning, and the timely realisation of new construction projects, conversions and refurbishments, are at the heart of its remit. The preservation of value and functionality is the result of needs-based planning, geared – also in the interests of the owner – towards cost/benefit considerations, as well as corresponding controlling at ETH Board level. The owner is kept abreast of this by way of reports from the ETH Board. The ETH Domain is committed to the sustainable development of its real estate portfolio and thus to sustainable real estate management. It does so in compliance with the Federal Council mandate under Art. 73 of the Federal Constitution, as well as the Federal Government's strategy for sustainability.

The climate package obliges the centralised and decentralised Federal Administration – and thus also the ETH Domain – to reduce annual greenhouse gas emissions by 50% compared to the starting year of 2006. The remaining greenhouse gas emissions must be fully offset with emission reduction certificates by 2030. The concrete realisation of the Federal Council's mandate for the climate package envisages that the expansion of electricity production to include solar energy on the appropriate areas will be actively pursued in new buildings and building renovations. Building services systems will continue to be geared towards efficient use of energy in the context of the optimisation of operations. What is new is that the replacement of fossil fuel plants with renewable energy plants will be forced by 2030 and thus a significant contribution can be made to the reduction of CO_2 emissions. Finally, in the context of mobility management, the charging infrastructure for electric vehicles will be further expanded on the sites of the institutions, in order to switch both their own vehicle fleet to energy-efficient electric vehicles and to offer employees a corresponding incentive to make the switch. On 3 September 2020, the Federal Council issued the implementation mandates.

The climate package focuses on individual measures included in the Federal Government's Exemplary Energy and Climate initiative (EEC), with which the ETH Domain has been actively demonstrating its commitment to the implementation of the Energy Strategy 2050 since 2014. The ETH Domain achieved an efficiency increase of 31.4% compared to the base year of 2006, thus exceeding the initiative's target of 25%. The share of renewable energies in final energy consumption rose from 44% to 75% in the same period.

The year 2020 was also dominated by the pandemic where environmental issues were concerned. It is foreseeable that all dimensions of sustainability will be affected. Both the energy consumption and the environmental impact of the ETH Domain show a significant deviation in the reporting period. Due to the pandemic, there was a significant decrease in air travel, a partial standstill of large-scale research facilities and an increasing degree of virtualisation of work. The numerous experiences with working from home and new findings on mobile-flexible forms of work have shaped the development of the concept for the introduction of desk-sharing and for the promotion of these forms of work. As a result, in December the Federal Council ordered the Federal Administration and the ETH Domain to introduce desk-sharing for office workplaces. Together with the increasing digitisation of the work, this will speed up the efficient use of the available office spaces. In spite of the difficult conditions, the institutions were able to continue important projects in the field of sustainable construction: since the winter half-year of 2019/2020, WSL has been heating the SLF's registered office in Davos with a groundwater heat pump. Thanks to electricity from local hydropower, all heat is now produced from 100% renewable sources. In addition, the first building of the ETH Domain certified according to the Standard Nachhaltiges Bauen Schweiz (SNBS) (Sustainable Building Switzerland) gold certificate is being planned with a replacement new building.

Thanks to the further expansion of the innovative "Anergy Grid Hönggerberg" project, ETH Zurich was awarded the Swiss energy prize Watt d'Or by the Swiss Federal Office of Energy (SFOE) in the reporting period (see also p. 17). With the inventory of materials for the first building, the university is also testing the potential for optimising material cycles and taking on a pioneering role in the important field of activity of the circular economy. The latter is a topic that the Urban Mining and Recycling Unit (UMAR) is researching in the modular NEST research and innovation building in Dübendorf. With the installation of a new heat exchanger at the district heating network on SwissFEL's site, the PSI was able to dispense with the planned second groundwater well. This will result in a saving of 175,000 m^3 of groundwater annually. The modernisation of the heating and cooling control centre with a lake water heat pump from EPFL is about to be completed, and commissioning will take place soon. The construction of a data centre directly above it will ensure efficient use of energy. Cooled by cold lake water, it will in future return the waste heat produced by the servers to the energy centre for recovery. In addition to the use of the heat contained in the seasonal energy grid by a heat pump on the Empa/Eawag site in Dübendorf, a large photovoltaic system on the roof of the laboratory building increased the in-house production of renewable energies by 80% to 356,000 kWh annually.

The year 2020 was also characterised by the preparatory work for the application of the revised procurement law with effect from 1 January 2021 and the associated new awarding culture with more quality competition, sustainability and innovation. The new focus demanded by the legislator on life-cycle costs in the procurement of goods, services and construction also makes environmental and energy issues more relevant in the procurement processes of the ETH Domain.

Strategic objective

WORKING CONDITIONS, EQUAL OPPORTUNITIES AND YOUNG SCIENTIFIC TALENT

Leadership culture, advice and diversity shaped human resources policy in 2020. All institutions havetaken measures to promote equal opportunities and, especially during the shutdown, to create a healthy work-life balance for families. Strengthening and expanding the culture of respect also remained a focus of our activities. Bullying, harassment, discrimination, threats and violence are not tolerated in the ETH Domain.

Focal points of human resources policy in 2020: Leadership culture, advice and diversity

The sustainable human resources policy developed over the years is lived by and continuously expanded in all institutions. With the Leadership Series, ETH Zurich supports the development of professors' leadership skills and the expansion of coaching and advisory services for all managers. Regulations have been drawn up to deal with inappropriate behaviour and the range of advisory services on offer has been expanded. EPFL kept its focus on the development of its human resources policy and digitisation. Other main topics at both Federal Institutes of Technology were the promotion, protection and support of employees as well as the development of leadership skills.

The PSI established the People Performance & Development Process (PPDR). The PPDR defines the key personnel and their succession planning, as well as creating a uniform standard in the MbO process (Management by Objectives) and the basis for targeted personnel development. The WSL conducted workshops on unconscious biases for all managers and introduced the Job Application Workshop as a pilot project for doctoral students and postdocs. The virtualisation of collaboration is increasingly promoting independence, entrepreneurial thinking and actions at all levels and strengthening mutual trust. Empa described this as an unprecedented challenge that they and all other institutions successfully overcame. Eawag expanded its continuing education programme and conducted indepth training courses for managers. It also analysed the staff appraisal process.

Partial revision of PVO and equal pay analysis

On 1 October 2020, the partial revision of the ETH Domain Personnel Ordinance (PVO-ETH) approved by the Federal Council entered into force. The amendments contained therein are being implemented across all institutions. The ETH Domain carried out an equal pay analysis involving an external consulting company. It thus met the requirements of the Gender Equality Act and the Charter for Equal Pay in the Public Sector. The results of the analysis were available on 31 December 2020 and will be published throughout the ETH Domain.

Executive promotion and management development

Professors as well as managers in the Technical and Administrative Domain of ETH Zurich benefited from further or newly developed services aimed at improving leadership skills. For example, it developed the seminar "Fit for your new managerial role" for technical and administrative staff. In the context of promoting a leadership culture, EPFL set up a specific management training programme for assistant professors with tenure track. It covers the basic skills required to run a laboratory on a daily basis.

In the summer, the PSI held a two-day seminar for senior management level staff for the development of executives and strategies. The resulting strategic initiatives contribute to the establishment of the PSI as a preferred employer and research location. The further development of the training of all managers and experts is carried out as a joint venture with FHNW (University of Applied Sciences and Arts Northwestern Switzerland) and the research institutions Empa, Eawag and WSL. Empa and Eawag also offer their managers seminars on leadership principles, communication and HR processes. All employees of the four research institutions also have access to numerous internal and external opportunities to develop their existing skills. In addition to FHNW CAS Leadership in Science, Eawag offered refresher courses on how to conduct staff appraisals and training courses on "unconscious bias".

Scientific career and parenthood
At ETH Zurich, the promotion and development of the career of postdocs and research associates is the focus of a broad discussion of a consultative nature. This discussion also includes the framework conditions that enable young researchers, mothers and fathers to continue working and to pursue a scientific career in the ETH Domain after parental leave. In concrete terms, the extension of existing employment relationships (with assistant professors) and workload flexibility are considered. EPFL and Eawag (Tailwind programme) already offer progressive solutions for parents. Empa also supports the re-entry into the working world after parental leave in the form of restart support. The career return programme at the PSI has already been established for more than ten years and is supplemented by part-time offers for mothers and fathers.

Supporting young scientists
Doctoral students at ETH Zurich can find out about career options and build up a network during the Career Weeks. ETH Zurich and EPFL allowed the renewal of contracts with doctoral students and postdocs if their new post could not be taken up due to the pandemic. Eawag also considered employment extensions for employees who could not implement their follow-up solution due to the pandemic.

The PSI participated in the Work Life Aargau initiative on the subject of a shortage of skilled workers and collaborated with FHNW and CH Media on the launch of an interactive web platform. It presents job seekers with comprehensive information about the partner companies and what characterises the canton of Aargau as a location. Together with four partner organisations, WSL organised a three-day workshop for doctoral students from eleven Swiss institutions to promote networking and collaboration among young scientists. Empa again conducted seminars for doctoral students this year to facilitate a career in industry.

Career opportunities for all roles
The strengthening of mentoring, the expansion of skills development and the clarification of mutual expectations play a central role for pursuing a career within and outside the ETH Domain. At ETH Zurich and EPFL, the prospects of a career within and outside the science sector are shown. The two programmes Expert Development Programme and the Professional Development Support Programme were evaluated at the PSI. WSL introduced a policy on training and further education. The results of this year's staff survey by Empa showed that it was able to maintain the status quo with its range of development opportunities. Eawag systematically evaluated the need for further training based on corresponding requests made in staff appraisals and adapted the existing offer to ensure that it meets the requirements of the labour market.

Supervision of doctoral students and postdocs
In several departments of ETH Zurich, postdocs and research associates receive a mentor alongside their line manager. The platforms were welcomed with open arms: Postdocs welcome event, Intrapersonal and interpersonal competencies, Design your (academic) Career, Essential Skills for a Successful Industry Career and Lateral Leadership. EPFL also makes a distinction between an academic career with the goal of a professorship and a scientific project career which is very important for many specialist areas.

The PSI carries out the Transferable Skills Programme for doctoral students and postdocs. The Research Integrity Information for PhD students and postdocs course is mandatory for all doctoral students and postdocs. WSL implemented guidelines for doctoral students and their supervisors and thus clearly supports the quality considerations that generally apply to a successful doctorate. It also introduced the Job Application Workshop for doctoral students and postdocs. Empa revised the framework conditions for the supervision and promotion of doctoral students and postdocs. Eawag offered mental health courses, presentation workshops, fellowships and career planning programmes.

Domestic labour force potential
In the ETH Domain, suitable measures are being taken, such as the advertising of vacant positions on Swiss job platforms, in order to meet the legal requirement to give priority to employees living in Switzerland. The corresponding statutory criteria and recommendations are taken into consideration in the recruitment of new employees.

Professional integration
For many years, the ETH Domain has already been employing people with restrictions on their ability to work and perform. ETH Zurich expanded its case management which provides active and systematic process

support to employees and their line managers in the event of an existing or foreseeable health-related incapacity for work. The PSI actively participated in the project "Leitfaden Entwicklung und Anpassung von Diversity & Inclusion Richtlinien mit Fokus Hörbehinderung" (Guide to the Development and Adaptation of Diversity & Inclusion Guidelines with a Focus on Hearing Impairment) of the Schweizerischer Gehörlosenbund (Swiss Federation for the Deaf). WSL approved various requests for work tests in the context of invalidity insurance (IV) reintegration measures and checked its infrastructure for accessibility. Empa and Eawag also worked with external public and private bodies and created further employment opportunities and jobs through individual measures.

Implementation of equal opportunities

On 1 March 2020, the Conciliation Commission was introduced in the ETH Domain in accordance with the Gender Equality Act. Issues such as ethnic origin, religion, social mobility or sexual orientation and gender identity are also becoming increasingly important. In 2020, ETH Zurich added two additional vice presidents to its Executive Board, within the departments of Personnel Development and Leadership and Knowledge Transfer and Corporate Relations. EPFL compiled a report to promote an increase in the proportion of women in management positions and decision-making bodies, which is a landmark for the composition of future management teams. In a poster campaign on International Women's Day on 8 March, the PSI presented women who work in traditional male occupations. In accordance with its gender strategy, WSL set up recruitment committees with equal representation of men and women. Empa and Eawag were also able to fill further executive positions with women. As of 1 January 2020, the proportion of women at Eawag was for the first time higher than that of men. This is a novelty in the ETH Domain.

A healthy balance between family life and work

In addition to the generally family-friendly working conditions of the ETH Domain, departments and professorships at ETH Zurich and EPFL are obliged to promote the reconciliation of work and family life for mothers and fathers. The annual ALEA Award at ETH Zurich puts this issue in the spotlight.

In order to relieve the burden on parents, EPFL increased the number of places available during the holidays and introduced a special offer for childcare during the school holidays. PSI created a website with helpful tools for families who want to combine looking after their children with working from home. WSL introduced a "120% rule" for postdocs, according to which mothers and fathers who spend more time looking after their children can reduce their workload and appoint a deputy. One full-time equivalent can thus be increased to a maximum of 1.2 FTE on an interim basis. A healthy work-life balance is firmly rooted in the culture of Empa, and it has received several awards for this. Eawag introduced the Mobile Working policy which regulates how to achieve this for employees who work from home. WSL has implemented a new policy on working from home which allows employees to work from home on a regular basis for up to two days per week following a joint agreement between employees and their line managers.

Become a scientist! To promote young women's interest in STEM professions promote, PSI featured women working in traditionally male professions in a poster campaign for International Women's Day on 8 March 2020 (implemented in German only).
› PSI

Promotion of diversity
In the ETH Domain, regular meetings are held with LGBTQ+ groups as well as with the Office of Equal Opportunities and Diversity (EQUAL). The first concrete measures, such as gender-neutral toilets, have already been implemented at ETH Zurich. The university featured the Black Lives Matter movement in various events in 2020. Since the beginning of 2019, there has been an advice and conciliation service called "Respect" which is responsible for the topics of bullying, (sexual) harassment and discrimination. A newly created independent external advice service supports the consistent implementation of Respect's code of conduct.

An EPFL committee assessed the status of professors and the continuous increase in the proportion of women in management positions. WSL managers are required to attend workshops on the topic of unconscious biases. Researchers from all institutions take part in the Fix the Leaky Pipeline! and CONNECT (Connecting Women's Careers in Academia and Industry) programmes. In the entire ETH Domain, workshops are offered to improve interpersonal skills. In 2020, Empa and Eawag organised the joint series of events "Women in Science".

Occupational safety, protection of privacy and health
In the ETH Domain, a large number of measures were taken during the pandemic to protect all members. ETH Zurich promotes the establishment of a respectful culture that does not give bullying, discrimination, harassment, threats and violence a chance. In this context, it adopted the rules on reporting inappropriate behaviour and extending the range of ombudspersons and advisory bodies available. EPFL, PSI, WSL and Empa also offer a comprehensive advisory network with contacts at various levels. The PSI continued and extended the measures initiated as part of the Safe@Work project and the periodic implementation of awareness campaigns.

During the pandemic, all ETH Domain employees benefited from online forums, information campaigns and advisory services such as the online exchange forum for managers or the online courses on emotion and stress regulation offered by WSL.

Eawag used the Swiss National Accident Insurance Fund's (Suva) workplace checks, drew up documents for the acquisition of the Workplace health management (BGM) label Friendly Work Space and held events and training courses.

Training apprentices
Through individual support services, young people with special needs are also able to successfully complete vocational education and training at all institutions and decisive added value is provided in the area of diversity. ETH Zurich provided 170 apprenticeship places in 15 occupational fields, revised its appearance at the job fair and enabled 180 young people to gain a better understanding of a wide range of professional fields. Apprentices and workplace trainers offered online information events on the newly created training platform "Lern mit mir" (learn with me).

In spring, EPFL launched a campaign with the task force Apprenticeship Prospects 2020 to create additional apprenticeships. The campaign was aimed at apprentices who had lost their apprenticeship due to the pandemic or had not yet found a new one. It was thus able to offer additional apprenticeships (+ 5%). The PSI is currently training over 100 apprentices in 15 professions who are regularly awarded regional and national prizes. In October, a PSI employee was able to secure his participation in the next WorldSkills in Shanghai by winning the gold medal as the best electronics engineer in Switzerland at the SwissSkills Championships. The winning of the bronze medal in the same occupational group by a second PSI apprentice rounded off this success. WSL is training 14 apprentices in eight professions in Birmensdorf and Davos. Empa was once again recognised as one of the best host companies for apprentices in Switzerland. It offers more than 40 apprentices in 10 different professions in-depth vocational training. Eawag created a second IT apprenticeship and trains 27 students in four occupational fields.

Conclusion, outlook and objectives
Comprehensive professional support and personnel management, strengthening strategic and operational management at all levels, as well as maintaining the values and developing the skills of all members are key concerns of the institutions of the ETH Domain. The high level of efficiency of the HR departments generates considerable added value in the global competition for the best talents. The ETH Domain takes issues such as respect, gender, diversity and inclusion seriously. In order to further anchor the culture of respect, which has a zero-tolerance policy towards bullying, harassment, discrimination, threats and violence, procedures, rights and obligations were clearly defined. The institutions follow a principle of dialogue, transparency and the protection of all persons involved.

Key Figures Personnel 2020

On 31 December 2020, the headcount in the ETH Domain stood at 23,472 employment contracts (ECs), or 20,117.0 full-time equivalents (FTEs) (see Fig. 16, p. 96). With an increase of 873 ECs (+3.9%) or 676.8 FTEs, the reported growth in headcount was higher than in the previous year. It was also above the usual values of between 2% and 3%. The largest share of personnel growth was accounted for by the two universities ETH Zurich and EPFL, where the increase in scientific personnel led to changes in all personnel categories.

The scientific personnel, which also includes doctoral students, remains by far the largest function group in the ETH Domain with 14,177 ECs (11,994.6 FTEs) (60.4% of the total headcount, see Fig. 16, p. 96), followed by the technical staff, which accounts for 4,045 ECs (3,676.3 FTEs) or 17.2% of the headcount. Of all employees, 16.4% or 3,890 ECs (3,118.9 FTEs) are administrative employees and 2.0% are apprentices. Professors account for 887 ECs (854.6 FTEs) or 3.8% of the total headcount.

Professors
In 2020, ETH Zurich and EPFL had a total of 701 full and associate professors and 134 assistant professors with tenure track (TT) and 52 assistant professors without TT (see Fig. 17, p. 96).

The proportion of women in the three categories grew from 17.2% to 18.5% in 2020. The figures were 15.3% for full and associate professors, 30.6% for assistant professors with TT and 30.8% for assistant professors without TT.

In 2020, 66.9% of the total of 887 professors came from abroad (2019: 66.6%). Of these 48.0% (2019: 52.4%) came from the EU area, and 18.9% from other countries (2019: 14.2%) (see Fig. 18, p. 97).

Financing the professorships
Of the 545 professors (524.7 FTEs) employed at ETH Zurich as of 31 December 2020, 469.2 FTEs (89.4%) were financed by the total federal contribution, 21.4 FTEs (4.1%) by SNSF, 9.2 FTEs (1.8%) by EU research programmes, and 24.4 FTEs (4.7%) by third-party financial research contributions, as well as by donations and bequests.

Of the 342 professors (329.9 FTEs) employed at EPFL as of 31 December 2020, 315.4 FTEs (95.6%) were financed by the total federal contribution, 3.1 FTEs by the SNSF and by Innosuisse (0.9%), 1.4 posts (0.4%) by special federal funding of applied research and EU research programmes, and 10.0 FTEs (3.1%) by third-party financial research contributions, as well as by donations and bequests.

Proportion of women
The proportion of women in the ETH Domain is constantly increasing. In the ERI period 2017–2020, it increased by 1.4% and stood at 35.4% at the end of 2020. In the same period, the proportion of women in management positions (from function level 10) increased in particular by 1.9% and rose to 21.6%. The proportion of women increased in particular in the two universities and at WSL. It varies according to function group, discipline and institution. The lowest proportion of women is at the PSI and Empa; the highest at Eawag (see Fig. 21, p. 98).

Apprentices
In the reporting period, the ETH Domain offered 473 apprentices an apprenticeship in more than 20 different career paths. Women accounted for 32.3% of apprentices in 2020.

KEY FIGURES

Monitoring table on the strategic objectives by the Federal Council

Fig. 3: Monitoring table on the strategic objectives set by the Federal Council for the ETH Domain for 2017–2020

	Reference values			Monitoring			
Indicators	2008	2013	2016	2017	2018	2019	2020
TEACHING							
Students and doctoral students ETH Zurich and EPFL (headcount)							
New admissions							
At Bachelor's level	4,052	5,255	5,531	4,756	4,827	4,966	5,245
Students	**16,233**	**22,099**	**24,217**	**25,059**	**26,140**	**27,275**	**28,637**
Proportion of women (%)	29.3	29.1	29.7	30.6	31.2	31.5	31.7
Proportion of foreign nationals (%)	27.3	35.5	37.4	38.4	39.3	40.7	40.7
At Bachelor's level	10,138	13,995	14,727	14,385	14,792	15,243	15,983
Proportion of women (%)	28.8	28.6	30.0	30.6	31.6	31.9	32.0
Proportion of foreign nationals (%)	23.8	30.9	31.6	29.4	30.4	31.9	32.6
At Master's level	4,649	7,241	8,662	8,895	9,517	10,163	11,143
Proportion of women (%)	28.0	29.4	28.5	29.4	29.6	29.8	30.3
Proportion of foreign nationals (%)	34.4	43.1	46.1	45.4	46.3	47.6	48.4
At Diploma level	751	0	0	0	0	0	0
On MAS / MBA programmes	695	863	828	840	827	809	816
Proportion of women (%)	34.2	34.6	37.9	38.8	40.6	40.3	42.6
Proportion of foreign nationals (%)	48.1	45.7	50.2	51.5	50.1	46.7	47.7
Visiting students[1]	–	–	–	939	1,004	1,060	695
Proportion of women (%)	–	–	–	35.5	32.9	34.9	33.7
Proportion of foreign nationals (%)	–	–	–	96.5	96.6	96.0	95.0
Supervision ratio							
Bachelor's and Master's students per professor	25.1	27.7	29.2	28.3	29.7	30.6	31.7
Doctoral students	**4,823**	**5,947**	**6,134**	**6,234**	**6,391**	**6,367**	**6,598**
Proportion of women (%)	28.6	30.4	31.0	30.8	31.4	32.8	33.6
Proportion of foreign nationals (%)	62.7	72.6	74.3	75.0	76.3	76.9	78.1
Supervision ratio							
Doctoral students per professor	7.8	7.7	7.7	7.6	7.8	7.7	7.7
Students and doctoral students	**21,056**	**28,046**	**30,351**	**31,293**	**32,531**	**33,642**	**35,235**
Proportion of women (%)	29.1	29.4	30.0	30.6	31.3	31.7	32.0
Proportion of foreign nationals (%)	35.4	43.3	44.9	45.7	46.6	47.5	47.7
Supervision ratio							
Students and doctoral students per professor	34.0	36.5	37.9	38.0	39.8	40.5	41.2
Degrees							
Bachelor	1,656	2,249	2,500	2,602	2,686	2,876	3,007
Diploma, Master	1,978	2,663	2,989	3,065	3,240	3,368	3,344
MAS / MBA	336	346	303	394	343	324	249
Doctorate	832	993	1,256	1,258	1,209	1,290	1,171
Teaching and supervision by the research institutes							
Teaching hours	15,569	15,670	18,023	17,992	18,659	18,717	18,553
Bachelor's, Master's and Diploma projects	391	532	575	602	623	639	608
Doctoral students	700	797	783	807	854	837	842
Proportion of women (%)	36.1	36.3	39.8	39.0	38.4	38.2	39.9
Proportion enrolled in the ETH Domain (%)	66.1	67.9	67.4	67.7	68.6	67.9	70.3
Proportion enrolled at a foreign university (%)	17.3	13.4	11.7	10.3	8.8	9.8	9.1

Indicators	Reference values 2008	2013	2016	Monitoring 2017	2018	2019	2020
RESEARCH							
Publications[2]	–	–	–	–	–	–	–
Research contributions, mandates and scientific services (in CHF millions)	–	–	**772.7**	**743.2**	**755.2**	**779.1**	**774.1**
of which Swiss National Science Foundation (SNSF)	141.6	209.0	257.4	260.3	254.7	259.7	262.6
of which Innosuisse	26.1	36.8	50.6	62.6	55.5	49.3	50.6
of which EU Framework Programmes for Research and Innovation (EU FPs)	97.7	135.2	142.1	139.2	141.8	151.6	146.4
KNOWLEDGE AND TECHNOLOGY TRANSFER (KTT)							
Invention disclosures[3]	–	–	–	343	358	329	310
Software notifications[3]	–	–	–	26	36	40	32
Patents	125	193	230	206	230	224	217
Licences	178	223	353	377	341	324	338
Spin-offs	46	43	50	48	55	59	66
STAFF (FTE)							
Professors	619.4	767.7	800.8	823.8	818.3	830.5	854.6
Proportion of women (%)	10.7	12.4	13.9	14.8	15.4	17.2	18.6
Proportion of foreign nationals (%)	61.8	67.1	68.0	67.2	67.3	66.8	67.3
Scientific staff	7,956.5	9,927.3	11,053.9	11,204.4	11,542.3	11,608.0	11,994.6
Technical staff	2,957.6	3,157.3	3,355.1	3,439.8	3,494.0	3,591.8	3,676.3
Administrative staff	1,771.2	2,279.0	2,577.8	2,690.0	2,804.7	2,952.3	3,118.9
Apprentices	386.0	435.0	463.7	473.6	461.1	457.6	472.6
FINANCES/REAL ESTATE							
Total federal contribution (expenditure ceiling perspective) (in CHF millions)	**1,949.4**	**2,271.4**	**2,453.8**	**2,530.8**	**2,530.9**	**2,581.2**	**2,596.1**
of which federal financial contribution	1,778.4	2,073.9	2,288.7	2,377.9	2,356.7	2,372.6	2,355.1
of which investment credit for construction in the ETH Domain[4]	170.9	197.5	165.1	152.9	174.2	208.6	241.0

[1] Mobility students have constituted a separate student category since 2017.
[2] Publishing activity is assessed every four years as part of the intermediate evaluation.
[3] Additional KTT indicators introduced in 2017
[4] The values for 2018, 2019 and 2020 deviate from the State financial statement (see side note p. 104).

Indicators and counting methods for the monitoring table and the academic achievement report

If not specified in more detail, the term "students" is always understood to mean students at Bachelor's and Master's levels, students on Master of Advanced Studies and Master of Business Administration (MAS/MBA) continuing education programmes, and mobility students (students who are studying at one of the Federal Institutes of Technology for one or two semesters but are registered at another university). Doctoral students are defined as a separate category. In cases of simultaneous enrolment on several disciplines or academic levels, the prioritised discipline or level is counted.

Students and doctoral students are included in "headcount". Foreign students and doctoral students form two sub-categories: foreign-educated foreign nationals who were resident abroad while obtaining the relevant necessary qualifications, and Swiss-educated foreign nationals who were resident in Switzerland while obtaining the relevant necessary qualifications. The employment level of all staff is counted in terms of full-time equivalents (FTE). Professors – both full and associate, as well as assistant professors, including those recipients of the Swiss National Science Foundation (SNSF) Eccellenza professorial fellowship – who are employed at one of the two Federal Institutes of Technology are taken into account in calculating the supervision ratio. Senior scientists and *Maîtres d'enseignement et de recherche* (MER) from both Federal Institutes of Technology correspond to the academic staff in management roles or senior management staff. Some of them are adjunct professors. To determine the "expanded" supervision ratio, the Senior Scientists and MER of both Federal Institutes of Technology are added to the professors. The teaching hours delivered by the research institutes do not include preparation time, only the time spent in the presence of students.

Academic achievement report

Fig. 4: Students and doctoral students by discipline

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Δ 2019 / 2020	
												in %
Architecture	**3,098**	**3,177**	**3,097**	**3,066**	**3,060**	**3,030**	**3,047**	**3,041**	**3,090**	**3,035**	**−55**	**−1.8**
ETH Zurich	1,900	1,950	1,852	1,783	1,805	1,771	1,823	1,855	1,904	1,923	19	1.0
EPFL	1,198	1,227	1,245	1,283	1,255	1,259	1,224	1,186	1,186	1,112	−74	−6.2
Civil and Geomatic Engineering	**2,727**	**2,900**	**3,074**	**2,946**	**2,882**	**2,860**	**2,791**	**2,777**	**2,716**	**2,700**	**−16**	**−0.6**
ETH Zurich	1,576	1,629	1,740	1,731	1,716	1,701	1,688	1,667	1,614	1,646	32	2.0
EPFL	1,151	1,271	1,334	1,215	1,166	1,159	1,103	1,110	1,102	1,054	−48	−4.4
Engineering Sciences	**6,391**	**6,816**	**7,245**	**7,502**	**7,903**	**8,069**	**8,398**	**8,699**	**9,081**	**9,577**	**496**	**5.5**
ETH Zurich	4,167	4,341	4,549	4,729	4,930	4,993	5,135	5,224	5,467	5,851	384	7.0
EPFL	2,224	2,475	2,696	2,773	2,973	3,076	3,263	3,475	3,614	3,726	112	3.1
Information and Communications Technology	**2,253**	**2,367**	**2,536**	**2,665**	**2,809**	**3,033**	**3,261**	**3,648**	**4,031**	**4,529**	**498**	**12.4**
ETH Zurich	1,082	1,083	1,158	1,247	1,405	1,536	1,753	1,991	2,246	2,560	314	14.0
EPFL	1,171	1,284	1,378	1,418	1,404	1,497	1,508	1,657	1,785	1,969	184	10.3
Exact and Natural Sciences	**4,476**	**4,780**	**4,883**	**4,944**	**5,145**	**5,442**	**5,595**	**5,810**	**5,940**	**6,290**	**350**	**5.9**
ETH Zurich	2,790	2,903	2,972	3,024	3,157	3,352	3,505	3,691	3,794	4,039	245	6.5
EPFL	1,686	1,877	1,911	1,920	1,988	2,090	2,090	2,119	2,146	2,251	105	4.9
Human Medicine[1]	**–**	**–**	**–**	**–**	**–**	**–**	**99**	**192**	**286**	**296**	**10**	**3.5**
ETH Zurich	–	–	–	–	–	–	99	192	286	296	10	3.5
Life Sciences	**3,314**	**3,708**	**3,879**	**3,990**	**4,051**	**4,216**	**4,312**	**4,500**	**4,624**	**4,859**	**235**	**5.1**
ETH Zurich	2,551	2,823	2,923	3,012	3,044	3,162	3,218	3,326	3,433	3,566	133	3.9
EPFL	763	885	956	978	1,007	1,054	1,094	1,174	1,191	1,293	102	8.6
System-oriented Natural Sciences	**2,261**	**2,201**	**2,159**	**2,211**	**2,284**	**2,411**	**2,437**	**2,520**	**2,538**	**2,569**	**31**	**1.2**
ETH Zurich	2,261	2,201	2,159	2,211	2,284	2,411	2,437	2,520	2,538	2,569	31	1.2
Management, Technology, Economics	**833**	**870**	**897**	**913**	**913**	**972**	**973**	**966**	**954**	**937**	**−17**	**−1.8**
ETH Zurich	584	583	549	579	582	571	583	573	560	566	6	1.1
EPFL	249	287	348	334	331	401	390	393	394	371	−23	−5.8
Humanities, Social and Political Sciences[2]	**276**	**268**	**276**	**300**	**310**	**318**	**380**	**378**	**382**	**443**	**61**	**16.0**
ETH Zurich	276	268	276	300	310	318	366	358	351	406	55	15.7
EPFL	–	–	–	–	–	–	14	20	31	37	6	19.4
Total students and doctoral students	**25,629**	**27,087**	**28,046**	**28,537**	**29,357**	**30,351**	**31,293**	**32,531**	**33,642**	**35,235**	**1,593**	**4.7**
ETH Zurich	17,187	17,781	18,178	18,616	19,233	19,815	20,607	21,397	22,193	23,422	1,229	5.5
EPFL	8,442	9,306	9,868	9,921	10,124	10,536	10,686	11,134	11,449	11,813	364	3.2
Women	**7,585**	**7,973**	**8,238**	**8,414**	**8,677**	**9,091**	**9,587**	**10,167**	**10,675**	**11,280**	**605**	**5.7**
ETH Zurich	5,292	5,445	5,560	5,701	5,873	6,164	6,563	6,917	7,304	7,768	464	6.4
EPFL	2,293	2,528	2,678	2,713	2,804	2,927	3,024	3,250	3,371	3,512	141	4.2
Foreign nationals	**10,456**	**11,437**	**12,152**	**12,354**	**12,804**	**13,615**	**14,290**	**15,160**	**15,993**	**16,799**	**806**	**5.0**
ETH Zurich	6,205	6,559	6,751	6,949	7,226	7,563	7,972	8,433	8,876	9,438	562	6.3
EPFL	4,251	4,878	5,401	5,405	5,578	6,052	6,318	6,727	7,117	7,361	244	3.4

[1] ETH Zurich introduced a Bachelor's degree in Human Medicine in 2017.
[2] EPFL introduced a Master's degree in Digital Humanities in 2017.

Fig. 5: Students and doctoral students by academic level

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Δ 2019 / 2020	
												in %
Bachelor's programmes	**12,600**	**13,359**	**13,995**	**13,944**	**14,292**	**14,727**	**14,385**	**14,792**	**15,243**	**15,983**	**740**	**4.9**
ETH Zurich	8,236	8,468	8,817	8,820	9,087	9,309	9,262	9,517	9,895	10,355	460	4.6
EPFL	4,364	4,891	5,178	5,124	5,205	5,418	5,123	5,275	5,348	5,628	280	5.2
Master's programmes	**6,568**	**6,981**	**7,241**	**7,781**	**8,126**	**8,662**	**8,895**	**9,517**	**10,163**	**11,143**	**980**	**9.6**
ETH Zurich	4,607	4,755	4,811	5,187	5,480	5,861	6,158	6,590	7,037	7,790	753	10.7
EPFL	1,961	2,226	2,430	2,594	2,646	2,801	2,737	2,927	3,126	3,353	227	7.3
MAS/MBA	**801**	**911**	**863**	**805**	**836**	**828**	**840**	**827**	**809**	**816**	**7**	**0.9**
ETH Zurich	659	763	661	634	640	635	646	635	626	644	18	2.9
EPFL	142	148	202	171	196	193	194	192	183	172	–11	–6.0
Visiting students[1]	**–**	**–**	**–**	**–**	**–**	**–**	**939**	**1,004**	**1,060**	**695**	**–365**	**–34.4**
ETH Zurich	–	–	–	–	–	–	449	480	467	317	–150	–32.1
EPFL	–	–	–	–	–	–	490	524	593	378	–215	–36.3
Total number of students	**19,969**	**21,251**	**22,099**	**22,530**	**23,254**	**24,217**	**25,059**	**26,140**	**27,275**	**28,637**	**1,362**	**5.0**
ETH Zurich	13,502	13,986	14,289	14,641	15,207	15,805	16,515	17,222	18,025	19,106	1,081	6.0
EPFL	6,467	7,265	7,810	7,889	8,047	8,412	8,544	8,918	9,250	9,531	281	3.0
Doctoral programmes	**5,660**	**5,836**	**5,947**	**6,007**	**6,103**	**6,134**	**6,234**	**6,391**	**6,367**	**6,598**	**231**	**3.6**
ETH Zurich	3,685	3,795	3,889	3,975	4,026	4,010	4,092	4,175	4,168	4,316	148	3.6
EPFL	1,975	2,041	2,058	2,032	2,077	2,124	2,142	2,216	2,199	2,282	83	3.8
Total students and doctoral students	**25,629**	**27,087**	**28,046**	**28,537**	**29,357**	**30,351**	**31,293**	**32,531**	**33,642**	**35,235**	**1,593**	**4.7**
ETH Zurich	17,187	17,781	18,178	18,616	19,233	19,815	20,607	21,397	22,193	23,422	1,229	5.5
EPFL	8,442	9,306	9,868	9,921	10,124	10,536	10,686	11,134	11,449	11,813	364	3.2

[1] Visiting students have constituted a separate student category since 2017.

Different counting methods used by the ETH Board and the FSO

The method of counting students and doctoral candidates used by the ETH Board differs from that used by the Federal Statistical Office (FSO). The differences are mainly due to the different approaches and tasks of the organisations involved. The aim of the FSO's counting method, according to the Swiss University Information System, is to achieve comparability nationwide; the ETH Board, on the other hand, is concerned with reflecting the Federal Council's strategic objectives, the priorities and the special aspects of the ETH Domain as effectively as possible. The difference in the figures is largely due to the fact that the ETH Board includes incoming mobility students in the total number of students.

Mobility students have constituted a separate student category since 2017. Prior to then, mobility students were included in the figures for students at Bachelor's and Master's levels. This should be borne in mind when comparing with previous years. Where exchange students are counted is important for the ETH Domain for reporting on the strategic objectives – especially for the sub-objective of "Promotion of national and international exchanges".

Fig. 6: New admissions to the Bachelor's level at ETH Zurich and EPFL

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Δ 2019 / 2020	
												in %
Architecture	646	599	604	564	573	569	437	450	468	498	30	6.4
Civil and Geomatic Engineering	638	620	613	486	493	488	366	370	383	403	20	5.2
Engineering Sciences	1,240	1,354	1,429	1,393	1,550	1,518	1,350	1,303	1,353	1,327	–26	–1.9
Information and Communications Technology	448	465	547	595	596	679	582	662	708	780	72	10.2
Exact and Natural Sciences	954	986	969	952	1,001	1,108	985	928	952	1,074	122	12.8
Human Medicine[1]	–	–	–	–	–	–	100	100	100	100	0	0.0
Life Sciences	578	700	744	721	695	778	635	696	725	719	–6	–0.8
System-oriented Natural Sciences	321	336	335	316	366	372	288	307	259	326	67	25.9
Management, Technology and Economics	–	–	–	–	–	–	–	–	–	–	–	–
Humanities, Social and Political Sciences	13	12	14	14	16	19	13	11	18	18	0	0.0
Total	**4,838**	**5,072**	**5,255**	**5,041**	**5,290**	**5,531**	**4,756**	**4,827**	**4,966**	**5,245**	**279**	**5.6**

[1] ETH Zurich introduced a Bachelor's degree in Human Medicine in 2017. New admissions in this discipline are limited to 100 and will therefore remain stable over the years.

Fig. 7: Percentage of women among students and doctoral students at ETH Zurich and EPFL

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
% at Bachelor's level	29.4	29.2	28.6	28.7	29.2	30.0	30.6	31.6	31.9	32.0
% at Master's level	29.2	28.7	29.4	29.5	28.6	28.5	29.4	29.6	29.8	30.3
% on MAS/MBA programmes	37.1	36.7	34.6	35.0	38.6	37.9	38.8	40.6	40.3	42.6
% of visiting students	–	–	–	–	–	–	35.5	32.9	34.9	33.7
% at Doctoral level	29.4	29.8	30.4	30.6	30.6	31.0	30.8	31.4	32.8	33.6

Fig. 8: Percentage of foreign nationals among students and doctoral students at ETH Zurich and EPFL

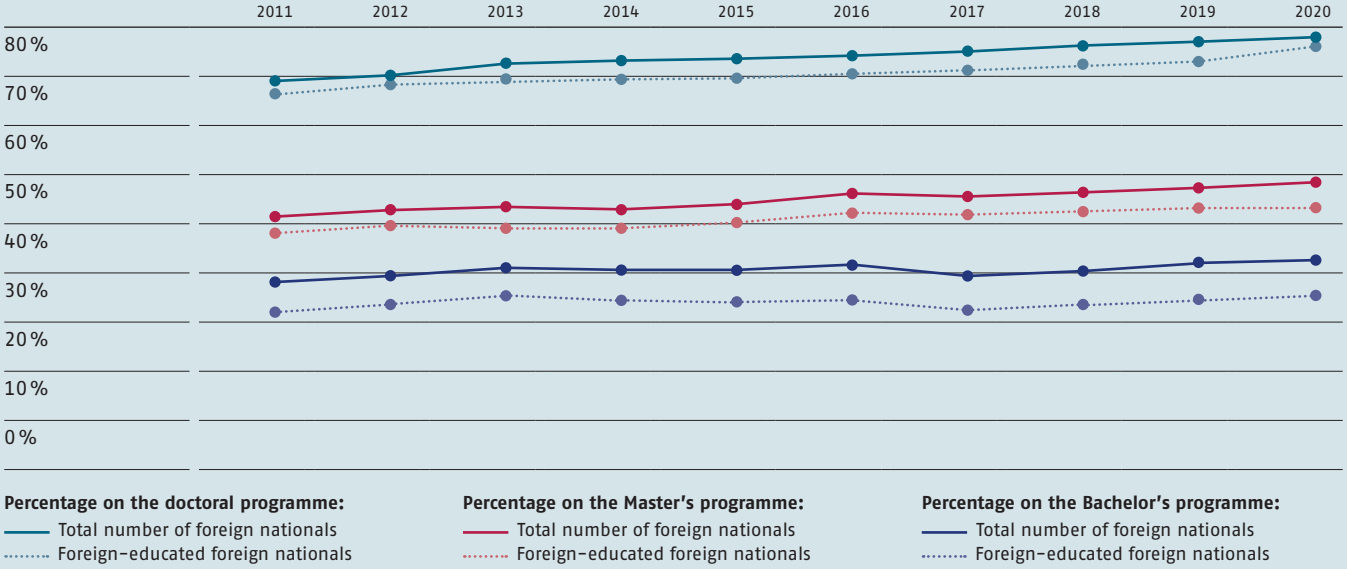


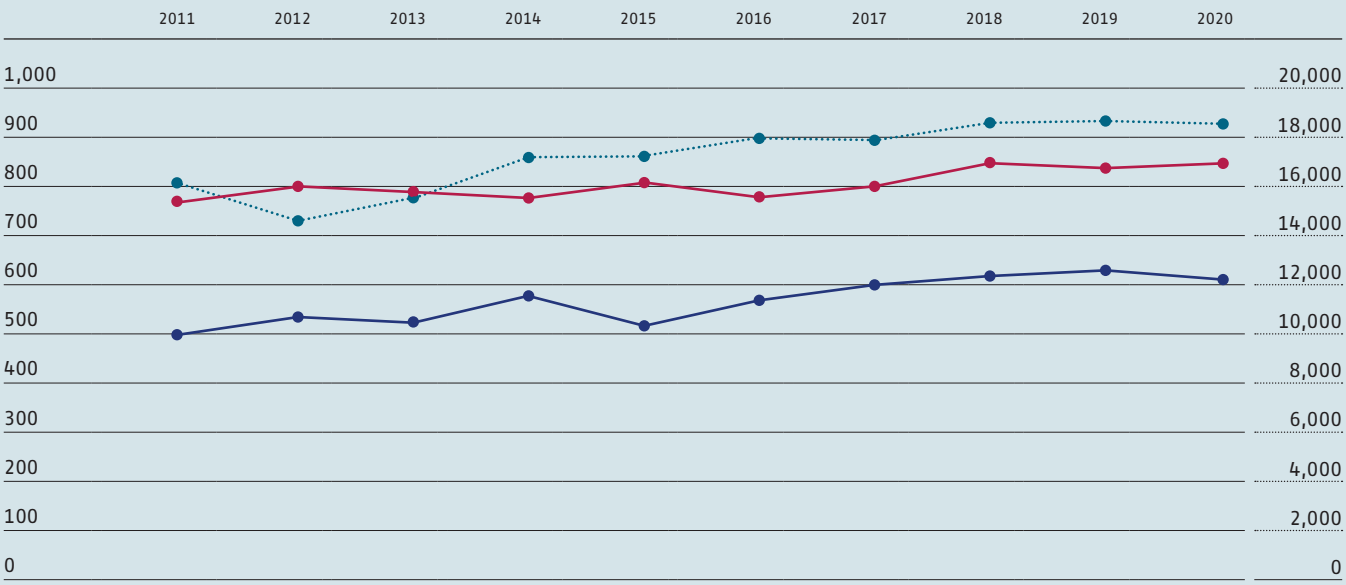
Fig. 9: Supervision ratios at ETH Zurich and EPFL

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Supervision ratio	**35.8**	**36.4**	**36.5**	**36.8**	**37.4**	**37.9**	**38.0**	**39.8**	**40.5**	**41.2**
at Bachelor's/Master's level	26.8	27.3	27.7	28.0	28.6	29.2	28.3	29.7	30.6	31.7
at Doctoral level	7.9	7.8	7.7	7.8	7.8	7.7	7.6	7.8	7.7	7.7
Extended supervision ratio	**23.7**	**24.5**	**24.7**	**24.7**	**25.3**	**25.7**	**25.8**	**26.8**	**27.4**	**27.9**
at Bachelor's/Master's level	17.8	18.4	18.7	18.8	19.3	19.8	19.2	20.0	20.7	21.5
at Doctoral level	5.2	5.3	5.2	5.2	5.3	5.2	5.1	5.3	5.2	5.2

Fig. 10: Degrees awarded by academic level

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Δ 2019 / 2020	
												in %
Bachelor	**1,988**	**2,216**	**2,249**	**2,538**	**2,528**	**2,500**	**2,602**	**2,686**	**2,876**	**3,007**	**131**	**4.6**
ETH Zurich	1,304	1,447	1,447	1,579	1,564	1,571	1,606	1,678	1,758	1,843	85	4.8
EPFL	684	769	802	959	964	929	996	1,008	1,118	1,164	46	4.1
Master	**2,159**	**2,320**	**2,663**	**2,711**	**2,821**	**2,989**	**3,065**	**3,240**	**3,368**	**3,344**	**–24**	**–0.7**
ETH Zurich	1,506	1,650	1,847	1,839	1,879	2,015	2,072	2,196	2,335	2,260	–75	–3.2
EPFL	653	670	816	872	942	974	993	1,044	1,033	1,084	51	4.9
MAS/MBA	**301**	**256**	**346**	**260**	**254**	**303**	**394**	**343**	**324**	**249**	**–75**	**–23.1**
ETH Zurich	203	184	228	205	175	203	272	232	245	160	–85	–34.7
EPFL	98	72	118	55	79	100	122	111	79	89	10	12.7
Doctorate	**1,027**	**1,095**	**993**	**1,197**	**1,109**	**1,256**	**1,258**	**1,209**	**1,290**	**1,171**	**–119**	**–9.2**
ETH Zurich	696	747	579	769	718	851	827	802	866	781	–85	–9.8
EPFL	331	348	414	428	391	405	431	407	424	390	–34	–8.0

Fig. 11: Teaching and supervision by research institutes



Left axis: Number of supervised Bachelor's, Master's, Diploma and doctoral theses
Right axis: Number of teaching hours per year

Number of supervised doctoral theses
Number of supervised Bachelor's, Master's and Diploma theses
Number of teaching hours per year

Knowledge and technology transfer

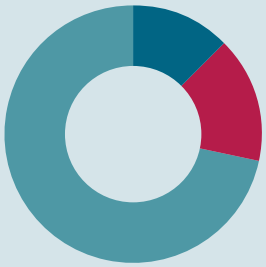
Fig. 12: Knowledge and technology transfer in the ETH Domain

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Invention disclosures[1]	**–**	**–**	**–**	**–**	**–**	**–**	**343**	**358**	**329**	**310**
ETH Zurich	–	–	–	–	–	–	171	205	159	165
EPFL	–	–	–	–	–	–	134	119	132	107
Research institutes	–	–	–	–	–	–	38	34	38	38
Software notifications[1,2]	**–**	**–**	**–**	**–**	**–**	**–**	**26**	**36**	**40**	**32**
ETH Zurich	–	–	–	–	–	–	20	19	26	18
EPFL	–	–	–	–	–	–	6	13	13	14
Research institutes	–	–	–	–	–	–	0	4	1	0
Patents	**147**	**195**	**193**	**211**	**219**	**230**	**206**	**230**	**224**	**217**
ETH Zurich	72	87	103	82	98	109	84	109	102	115
EPFL	52	75	66	99	88	100	95	95	98	75
Research institutes	23	33	24	30	33	21	27	26	24	27
Licences	**194**	**230**	**223**	**270**	**311**	**353**	**377**	**341**	**324**	**338**
ETH Zurich	45	35	38	35	50	78	82	87	62	43
EPFL	50	31	41	46	48	58	50	39	50	53
Research institutes	99	164	144	189	213	217	245	215	212	242
Spin-offs	**40**	**38**	**43**	**49**	**48**	**50**	**48**	**55**	**59**	**66**
ETH Zurich	22	22	24	22	25	25	25	27	30	34
EPFL	15	12	12	24	18	20	15	25	23	25
Research institutes	3	4	7	3	5	5	8	3	6	7

[1] Invention disclosures and software notifications were introduced in 2017 as additional KTT indicators.
[2] Open Source Software not included

Licences

338



ETH Zurich	43
EPFL	53
Research institutes	242

Invention disclosures

310

Software notifications

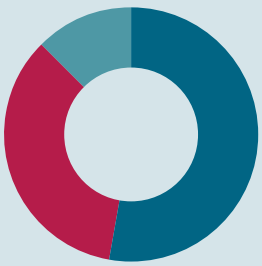
32

Spin-offs

66

Patents

217



ETH Zurich	115
EPFL	75
Research institutes	27

Fig. 13: Cooperation with the private and public sector

	2017	2018	2019	2020
Collaboration contracts with the private sector	**507**	**594**	**570**	**610**
of which financed by the private sector	**316**	**415**	**404**	**388**
ETH Zurich	122	149	163	143
EPFL	99	120	125	95
Research institutions	95	146	116	150
of which financed by Innosuisse/EU FPs*	**191**	**179**	**166**	**222**
ETH Zurich	57	74	55	72
EPFL	66	49	61	56
Research institutions	68	56	50	94
Collaboration contracts with the Swiss public sector	**285**	**261**	**278**	**262**
ETH Zurich	88	100	88	92
EPFL	54	43	51	47
Research institutions	143	118	139	123

Number of new cooperation agreements (research agreements and scientific services) with the private and Swiss public sector involving a volume of at least CHF 50,000 per contract. These indicators were introduced in 2017.
* EU FPs: European Framework Programmes for Research and Innovation

KTT indicators and counting methods

The patents correspond only to first filing, and the licences also include technology transfer agreements. The invention disclosures and software notifications correspond to the reports and notifications submitted in writing to the Technology Transfer Offices of the institutions of the ETH Domain in the reporting period. They reflect activities in the early phases of the innovation process, thereby supplementing the other KTT indicators. Open source software is not considered.

In order to reflect the cooperation between the institutions and private enterprise and the public sector, only recently concluded cooperation agreements are included. These are only research contracts and scientific services with a volume of at least CHF 50,000 per contract.

Cooperation with the private sector is divided into two categories: projects that are directly financed by industry in Switzerland or abroad; and those funded by Innosuisse or the EU Research Framework Programmes for Research and Innovation (EU FPs). Cooperation with the public sector includes contracts with public sector institutions in Switzerland, but not those with national or international research funding organisations and foundations.

Rankings observed worldwide (see Fig. 14 and 15)

The universities are assessed and ranked by institutions and businesses using various methods. THE (Times Higher Education World University Rankings) uses 13 key performance indicators for teaching (30% weighting), research (30%), citations (30%), international outlook (7.5%) and funding by industry (2.5%). QS (QS World University Rankings) focuses mainly on reputation (with a 40% weighting on academic reputation and 10% on reputation of graduates among employers), followed by the supervision ratio (20%), citations (20%) and international outlook (10%). ARWU (Academic Ranking of World Universities of Shanghai Ranking Consultancy) makes use of performance indicators for the quality of graduates and teaching staff that are based on the number of prestigious awards received (Nobel Prize, Fields Medal) and the number of frequently-cited researchers.

The publication activity is judged on the basis of the number of publications that have appeared in a select group of the most respected journals, and the ratio between the number of publications and the number of researchers at an institution. CWTS Leiden (Centre for Science and Technology Studies Leiden Ranking) is based solely on the publication activity of the universities, using this to calculate the indicators to assess research performance. One commonly used indicator for ranking the universities in the CWTS Leiden ranking is the proportion of publications each university has among the top 10% of the most-cited publications in the relevant discipline (PP(top 10%)). The CWTS Leiden World and Europe rankings of both Federal Institutes of Technology (see Fig. 14) are based on this indicator.

University rankings

Fig. 14: Rankings of ETH Zurich (blue) and EPFL (red) according to the THE, QS, ARWU and CWTS Leiden Rankings in 2020/2021

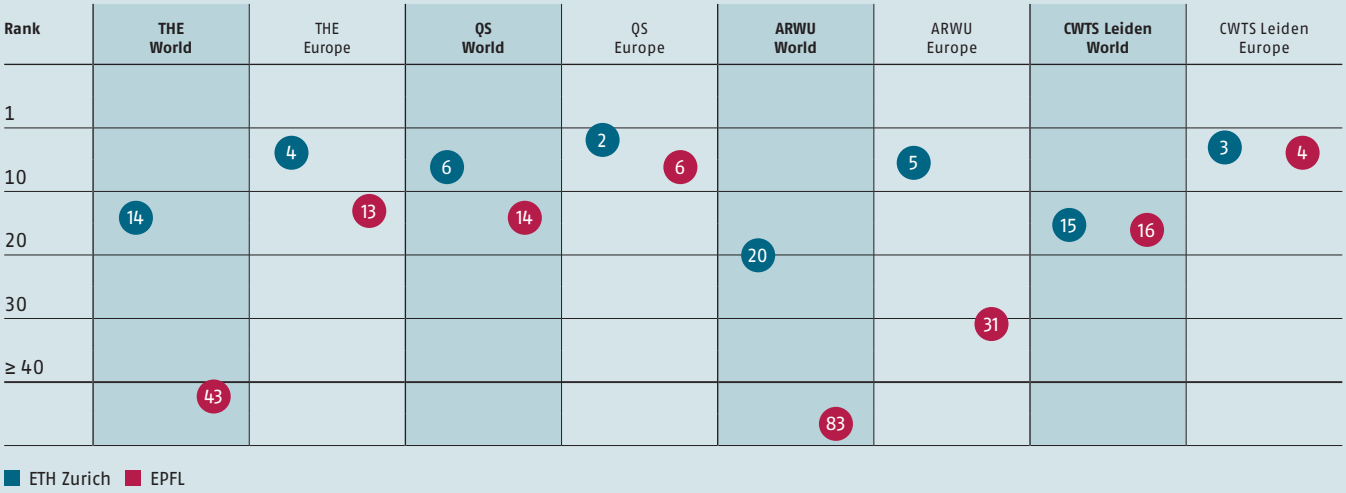
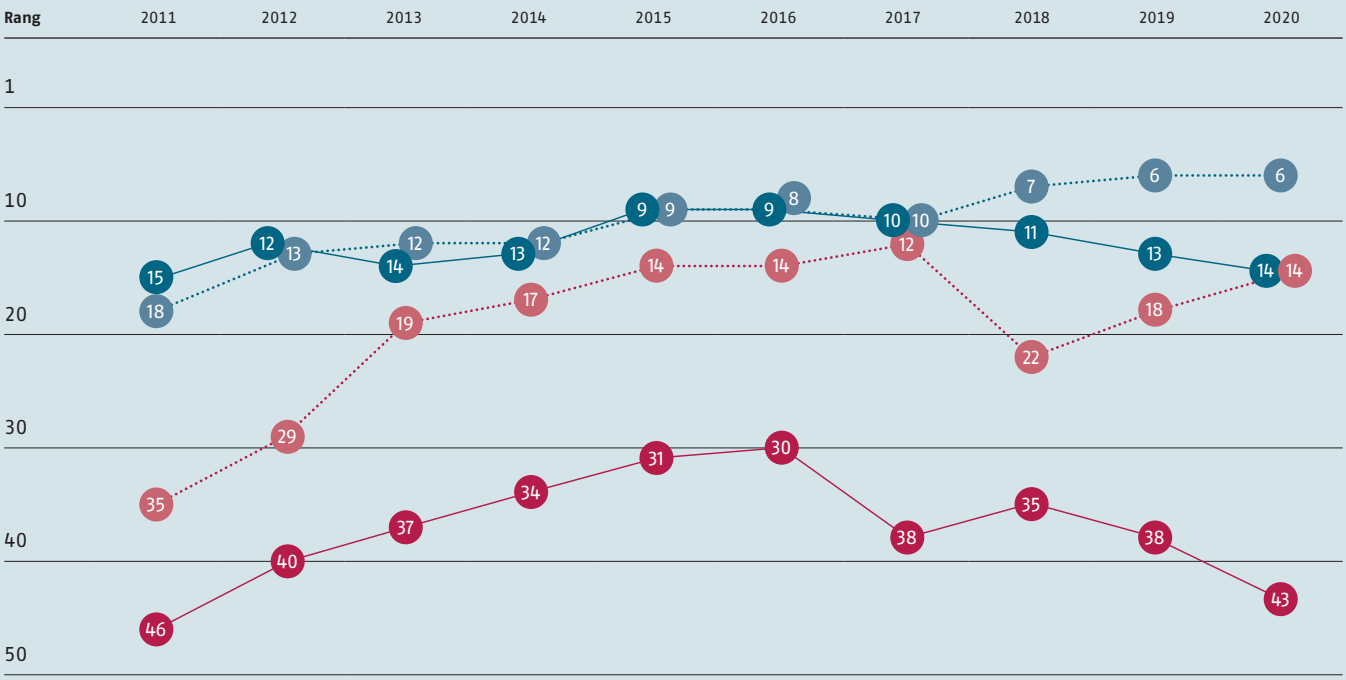


Fig. 15: Rankings of ETH Zurich (blue) and EPFL (red) according to the THE and QS World Rankings 2011–2020



THE **Times Higher Education World University Rankings** from TES Global Limited, London
QS **QS World University Rankings** from Quacquarelli Symonds Limited, London
ARWU **Academic Ranking of World Universities** from ShanghaiRanking Consultancy
CWTS Leiden **CWTS Leiden Ranking** from the Centre for Science and Technology Studies (CWTS) of the University of Leiden, Netherlands; Indicator used PP (top 10%) (see box on the left)

Personnel

Fig. 16: Headcount and employment level by function group

	Men			Women			ETH Domain		
2020	EC	FTE	ø EL %	EC	FTE	ø EL %	EC	FT	ø EL %
Professors (F/A)	594	567.6	95.6	107	103.1	94.6	701	670.7	95.7
Assistant professors with tenure track	93	93.0	100.0	41	41.0	100.0	134	134.0	100.0
Assistant professors without tenure track	36	34.7	96.4	16	15.2	95.0	52	49.9	96.0
Scientific personnel	9,686	8,312.2	85.8	4,491	3,682.4	82.0	14,177	11,994.6	84.6
of whom senior scientific personnel	689	660.4	95.8	117	106.9	91.4	806	767.3	95.2
Technical personnel	3,123	2,942.4	94.2	922	733.9	79.6	4,045	3,676.3	90.9
Administrative personnel	1,315	1,163.0	88.4	2,575	1,955.9	76.0	3,890	3,118.9	80.2
Apprentices	320	320.0	100.0	153	152.6	99.7	473	472.6	99.9
Total	**15,167**	**13,423.9**	**88.6**	**8,305**	**6,684.1**	**80.5**	**23,472**	**20,117.0**	**85.7**

Headcount (employment contracts, EC) and employment level (EL) of men, women and the entire ETH Domain by function group. As of 2010, the senior scientists, maîtres d'enseignement et de recherche (MER) and other senior personnel are counted separately, but nevertheless are still included under scientific personnel. A total of 6,598 doctoral students are enrolled at the two Federal Institutes of Technology. Of these, all who are employed in the ETH Domain are included under scientific personnel.

Fig. 17: Development in the numbers of female and male professors

	2020			2019			Changes		
	Men	Women	Total	Men	Women	Total	Men in %	Women in %	Total in %
Professors (F/A)	594	107	701	589	102	691	0.8	4.9	1.4
Assistant professors with tenure track	93	41	134	90	32	122	3.3	28.1	9.8
Assistant professors without tenure track	36	16	52	35	14	49	2.9	14.3	6.1
Total professors	**723**	**164**	**887**	**714**	**148**	**862**	**1.3**	**10.8**	**2.9**

Change in the number of professors according to: full (F) and associate professors (A), assistant professors with tenure track and assistant professors without tenure track. The three last columns show the percentage change since the previous year.

Professorial categories

The various professorial categories differ with regard to status and employment conditions. Full (F) and associate (A) professors, and assistant professors with and without tenure track (TT) teach and undertake research at both Federal Institutes of Technology. The latter can become permanently employed as full or associate professors if they meet a certain performance target. Full and associate professors are appointed permanently, while assistant professors sign employment contracts for a maximum of four years. The latter can be renewed for up to another four years.

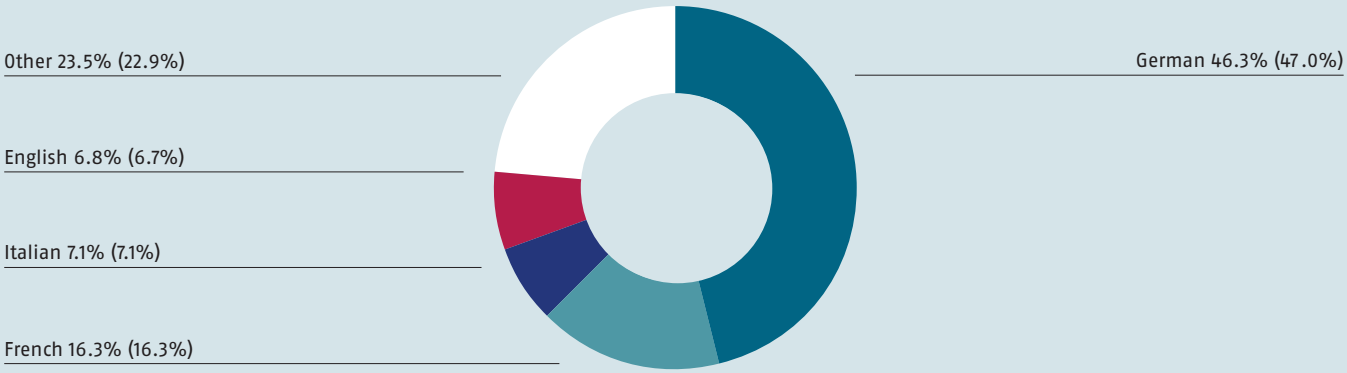
From 1 March 2017, a new provision in the ETH Ordinance concerning Professors came into force, expanding the category of full professors and regulating the framework conditions for the appointment of the affiliated professors. The embedding of the framework conditions will enable both Federal Institutes of Technology to pursue more selective and intensive cooperation with research institutions at home and abroad. On the basis of a pre-existing institutional cooperation agreement, selected individuals from domestic and foreign research institutions may be appointed as affiliated professors at one of the two Federal Institutes of Technology.

Fig. 18: Origin of male and female professors

	Switzerland			EU			Other		
2020	Men	Women	Total	Men	Women	Total	Men	Women	Total
Professors (F/A)	228	32	260	283	56	339	83	19	102
Assistant professors with tenure track	12	5	17	47	20	67	34	16	50
Assistant professors without tenure track	13	4	17	11	9	20	12	3	15
Total professors	**253**	**41**	**294**	**341**	**85**	**426**	**129**	**38**	**167**

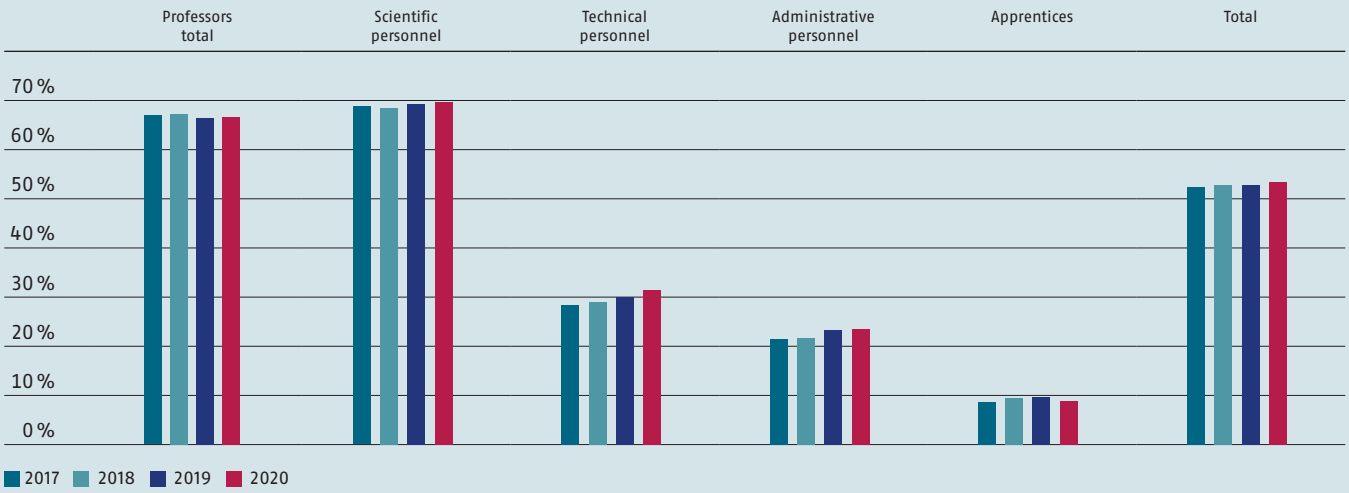
Number of professors broken down by origin: Switzerland, the EU and other countries

Fig. 19: Employees' native languages



Native languages of employees in the ETH Domain in 2020. Figures for the previous years are shown in brackets.

Fig. 20: Development in the proportions of foreign employees by function group



Development in the proportions of foreign employees in the ETH Domain by function group (in relation to the number of employment contracts)

Fig. 21: Development in the proportion of women by institution

Development in the proportion of women by institution over the past four years (in relation to the number of employment contracts)

Fig. 22: Source of funds by function group

Function group		Professors (all)	Scientific personnel	Technical personnel	Administrative personnel	Total FTE
Source of funds						
Total federal contribution Federal financial contribution	2019	767.8	5,859.0	2,951.4	2,660.2	12,238.4
	2020	784.6	6,041.1	3,004.7	2,776.3	12,606.7
	Δ 2019 / 2020	16.8	182.1	53.3	116.1	368.3
Third-party resources Research funding (SNSF, Innosuisse, other), government-funded research and EU Framework Programmes for Research and Innovation (EU FPs)	2019	30.0	4,155.3	243.2	104.4	4,532.9
	2020	35.6	4,360.5	273.8	106.3	4,776.2
	Δ 2019/2020	5.6	205.2	30.6	1.9	243.3
Industry-oriented research, donations/bequests	2019	32.5	1,596.3	395.3	187.2	2,211.3
	2020	34.4	1,593.3	397.5	236.3	2,261.5
	Δ 2019/2020	1.9	−3.0	2.2	49.1	50.2
Total	2019	830.3	11,610.6	3,589.9	2,951.8	18,982.6
	2020	854.6	11,994.9	3,676.0	3,118.9	19,644.4
	Δ 2019/2020	24.3	384.3	86.1	167.1	661.8

Source of funds according to function groups (in FTEs) in 2020 compared to 2019. Δ (delta) shows the absolute change compared to the previous year. Figures exclude apprentices (472.6 FTEs) and trainees.

Real estate

Fig. 23: Source of funds for ETH Domain constructions (in CHF millions)

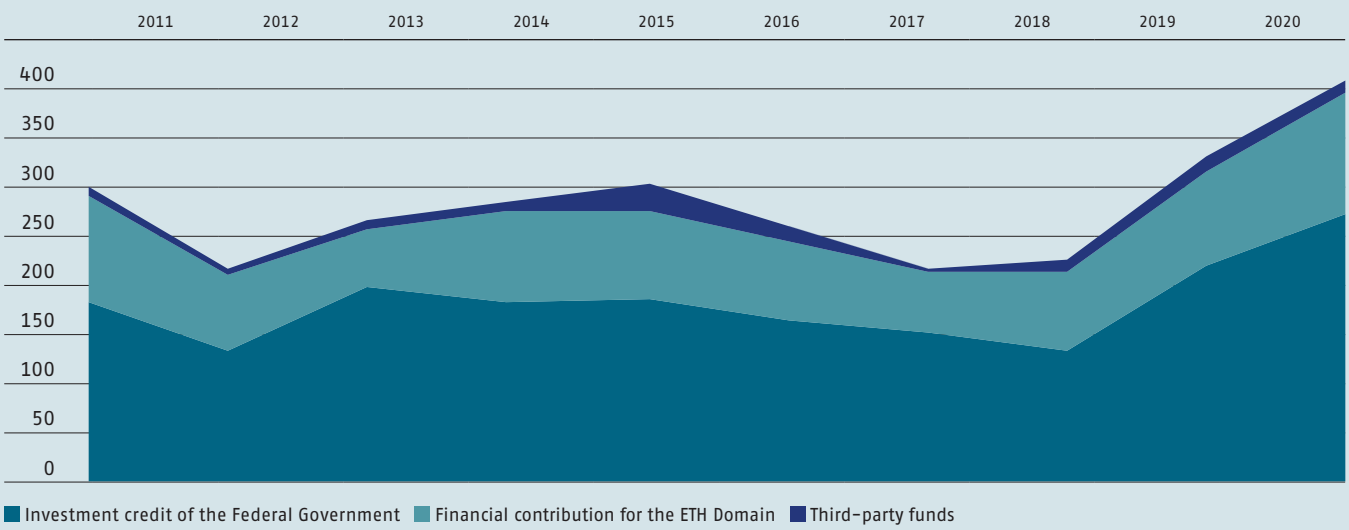
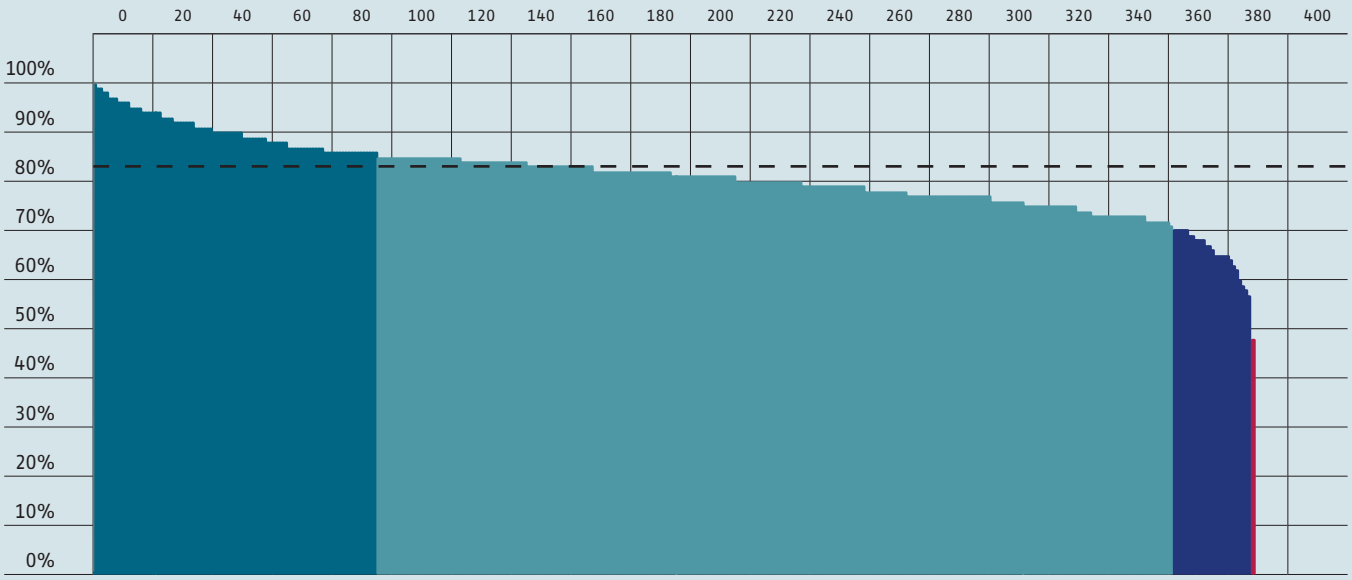


Fig. 24: Condition value as of 31 December 2020



Number of properties recorded: 388

Very good condition, as new
Good condition, no measures needed
Average weighted by original value of properties: 82%
Average condition, plan and implement measures
Poor condition, measures needed

Fig. 25: Development of the main usable area by institution in %

Fig. 26: Mix of areas (in 1,000 m²)

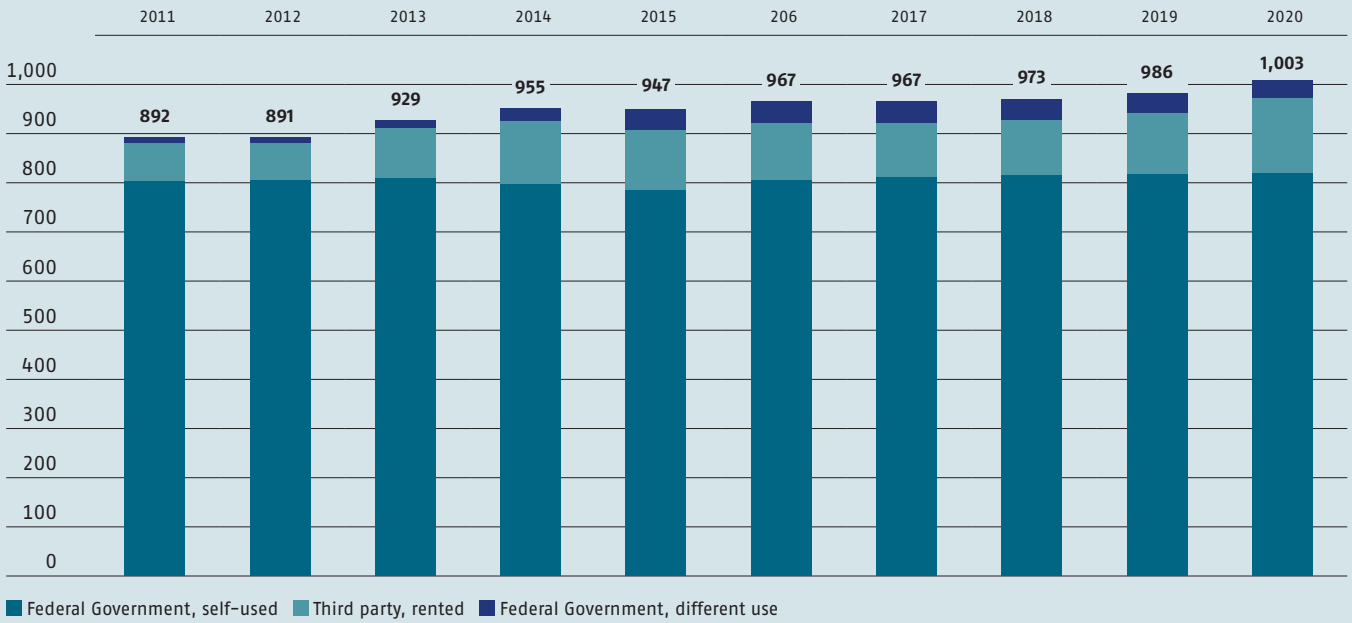


Fig. 27: Quantity structure of the ETH Domain portfolio

CHF millions	ETH Zurich	EPFL	PSI	WSL	Empa	Eawag	Total
Buildings/facilities							
Quantity	161	86	138	23	28	13	449
Original value	3,612	1,657	634	102	368	102	6,476
Book value	1,258	831	222	43	90	46	2,490
Plots							
Quantity	68	20	14	15	4	4	125
Book value	693	243	30	24	63	10	1,064
Book value of installations under construction	438	88	13	2	8	24	574
Building rights (not valuated, in compliance with regulations)							0
Total assets (book value real estate)	**2,389**	**1,162**	**265**	**68**	**162**	**81**	**4,128**
Provisions (e.g. for polluted sites, asbestos, radioactive waste)							270

Quantity and value of all government-owned real estate allocated to the institutions of the ETH Domain

Fig. 28: Investments

CHF 1,000	ETH Zurich	EPFL	PSI	WSL	Empa	Eawag	Total
Investment credit from Federal Government	194,270	45,700	13,590	1,430	5,640	10,400	271,030
of which for new or replacement constructions	98,349	14,420	8,709	583	4,883	10,201	137,145
of which for maintenance of value and functionality	95,921	31,280	4,881	847	757	199	133,885
Financial contribution investments (for user-specific construction)	86,796	25,824	6,670	126	3,381	2,336	125,133
Third-party resources	11,390	0	0	0	1,228	0	12,618
Construction expenses of the Institutions	292,456	71,524	20,260	1,556	10,249	12,736	408,780
Main usable area (m²)	504,220	290,560	113,010	18,230	59,720	17,380	1,003,120
Construction expenses per m² main usable area (CHF/m²)	580	246	179	85	172	733	408

2020 investments in the ETH Domain portfolio, based on the main usable area (in m^2). This is the part of the usable area that is directly allocated to the core task of teaching and research. Because the research institutes themselves do not provide teaching, a figure for the area across the entire Domain – for example in relation to the number of students – would not be very informative.

Environment and energy

Fig. 29: Environment and energy data

		ETH Domain 2018	ETH Domain 2019	ETH Zurich Total	EPFL Total	PSI Total	WSL Total	Empa Total	Eawag Total	ETH Domain Trend 2020[1]
BASIC DATA										
Energy reference area (ERA)[2]	m^2	1,470,019	1,461,445	692,616	426,673	169,650	20,964	123,442	28,100	1,466,089
Full-time equivalent[3]	FTE	37,532	38,453	22,183	11,765	2,053	724	1,042	686	
ENERGY[4]										
Final energy, net[7]	**kWh/a**	**435,890,829**	**433,298,723**	**184,193,800**	**99,418,680**	**125,728,700**	**4,713,270**	**15,133,308**	**4,110,965**	**438,432,862**
Electricity, net (not incl. self-produced)	**kWh/a**	**346,882,764**	**338,918,497**	**130,235,000**	**72,680,000**	**119,033,700**	**3,068,186**	**10,498,570**	**3,403,041**	
Consumption of uncertified electricity	kWh/a	43,870,141	40,823,700	1,790,000		39,033,700	0	0	0	
Consumption of certified electricity	kWh/a	303,012,623	298,094,797	128,445,000	72,680,000	80,000,000	3,068,186	10,498,570	3,403,041	
Electricity (without naturemade star)	kWh/a	293,836,779	289,168,394	124,445,000	70,865,000	80,000,000	886,636	12,971,758		
Photovoltaic naturemade star	kWh/a	2,085,290	2,085,076		2,000,000				85,076	
Hydropower naturemade star	kWh/a	13,954,314	13,902,965	4,000,000	4,585,000		2,000,000		3,317,965	
Wind naturemade star	kWh/a	100,000	181,550				181,550			
Sale of electricity	kWh/a	−6,963,760	−7,243,188		−4,770,000			−2,473,188		
Heat	**kWh/a**	**87,509,035**	**93,583,133**	**53,958,800**	**26,537,400**	**6,527,000**	**1,217,271**	**4,634,738**	**707,924**	
Fuel oil	kWh/a	8,613,209	6,468,680	350,000	5,501,000	498,000	117,981	0	1,699	
Natural gas	kWh/a	50,769,631	61,567,793	36,103,000	20,823,000	0	0	4,641,793		
District heating	kWh/a	51,884,009	51,263,195	43,295,800	533,000	6,029,000	0	699,170	706,225	
Woodchip	kWh/a	1,136,016	1,099,290	0	0	0	1,099,290	0	0	
Sale of heat	kWh/a	−24,893,830	−26,815,825	−25,790,000	−319,600	0	0	−706,225	0	
Fuels (own vehicles)	**kWh/a**	**1,499,030**	**1,598,376**	**801,283**	**201,280**	**168,000**	**427,813**	**0**	**0**	
Energy: additional information										
Energy costs, electricity and heat[5]	CHF/a	48,131,104	51,282,272	26,970,679	10,923,378	10,576,567	492,218	1,828,601	490,829	49,415,678
Self-generated renewable electricity	kWh/a	2,718,349	2,820,765	246,471	2,000,000	0	49,520	355,650	169,124	
Total sale to third parties	kWh/a	−31,857,590	−34,059,013	−25,790,000	−5,089,600	0	0	−3,179,413	0	
WATER (DRINKING WATER)	M^3	680,576	696,654	366,357	181,907	113,779	7,737	22,023	4,851	524,748
MATERIALS										
Paper	**kg**	**284,909**	**234,464**	**141,500**	**51,549**	**22,284**	**5,961**	**8,566**	**4,604**	**203,182**
Paper, new fibre	kg	82,817	70,921	21,500	34,776	9,111	806	125	4,603	41,409
Paper, recycled	kg	202,092	163,543	120,000	16,773	13,173	5,155	8,441	1	161,773
KEY FIGURES: ENVIRONMENTAL IMPACT										
Primary energy[6]	**kWh/a**	**587,599,808**	**578,932,282**	**208,671,648**	**120,229,909**	**219,239,419**	**7,244,746**	**18,253,599**	**5,292,961**	
Proportion of renewable energies	**%**	**65**	**66**	**59**	**59**	**76**	**58**	**68**	**77**	
CO_2 emissions	**t CO_2/a**	**36,630**	**37,279**	**16,512**	**9,511**	**9,225**	**366**	**1,366**	**299**	

[1] Provisional figures for the reporting period (trend), as at: start of March 2021
[2] The energy reference area is the sum of all gross floor areas, above and below ground, which must be heated or air-conditioned in order to be used.
[3] The FTE (full-time equivalent) value listed here was supplemented by the number of students with an FTE value of 0.68 to produce the consumption per person.
[4] The key figures indicated for electricity and heat show the total consumption of both for buildings, as well as for teaching and research activities.
[5] The key indicator "energy costs" shows all expenditure (cash out) for the provision of energy (heat and electricity).
[6] In energy economics, one refers to primary energy as the energy that is available using the original forms or resources of energy, such as fuel (e. g. coal or natural gas), as well as energy carriers such as sun, wind or nuclear fuels.
[7] Final energy is the portion of the primary energy that is left after losses due to energy conversion and transmission, after it is supplied via the consumer's domestic connection. The final energy basically corresponds to the energy that is purchased.

FINANCES

* Extract of the Financial Report 2020

Financial Report:
www.ethboard.ch/financialreport2020

Financial overview

In the 2020 financial year, the ETH Domain faced many complex challenges due to the coronavirus pandemic. The institutions responded appropriately during emergency mode and continued to be reliable partners. The ETH Domain's stable overall financing base made a significant contribution to this. Construction activity went ahead as planned and resulted in high expenses in 2020.

The ETH Domain's expenditure ceiling for the period from 2017 to 2020

The expenditure ceiling for the ETH Domain in the ERI period from 2017 to 2020 amounted to CHF 10,337.8m. It was approved by the Federal Parliament on 16 September 2016 with FedD 4. The total credits approved for the period from 2017 to 2020 amounted to CHF 10,239.0m. Utilisation at the end of the performance period was thus 99%. This resulted in an average annual growth rate of 1.4% (calculated based on the 2016 budget). It was slightly below the targeted growth of 1.9% according to the ERI Dispatch 2017–2020, as a result of the inflation correction and waiver planning.

Figure 30 shows the expenditure ceiling and the loans for the ETH Domain in the ERI period from 2017 to 2020.

Approved loans in 2020

The annual total federal contribution allocated to the ETH Domain is made up of the expenditure credit (A231.0181: federal financial contribution) and the investment credit (A202.0134: investments in constructions of the ETH Domain. The Federal Assembly approved CHF 2,596.1m in FedD Ia for the 2020 budget for both loans which are credited against the expenditure ceiling. Compared with 2019 (CHF 2,581.2m), the increase was CHF 15.0m (+0.6%). This rise also includes the budget increase of CHF 29.97m (compared to the proposal under the FCD by the Federal Assembly, August 2019). In 2020, there was a credit shift (CHF 60m) debited to the federal financial contribution.

Financial overview of the ETH Domain

In the preceding paragraphs, the total federal contribution was displayed based on the approved loans. In contrast, in the following paragraphs the total federal contribution is displayed in a revenue-increasing manner, i.e. on the basis of the funds received by the ETH Domain and supplemented by the revenue from third-party funding.

On the one hand, the total federal contribution covers the basic equipment for teaching and research, and on the other hand it is used to finance real estate used by the ETH Domain that is largely owned by the Federal Government. The Federal Government has transferred the management of the state-owned real estate used to the ETH Domain. Investments triggered and monitored by the ETH Domain in this real estate are explained in the Annual Report, from page 75 onwards. Only by including the investment credit (inflow of funds) that is located at the Federal Office for Buildings and Logistics (FOBL) (VE 620 Confederation as parent entity) and investments in state-owned real estate is it possible to provide a financial overview of the funds received by the ETH Domain and their appropriation. The financial overview therefore reflects the political control exercised by the Federal Government, irrespective of the ownership status of the real estate.

Monitoring sets out the credits approved in accordance with FedD Ia for the budget. In the state financial statements (Volume 2 B) and in this chapter from "Source and allocation of funds" onwards, however, the expenses are shown. In the period from 2018 to 2020, this led to different values for the investment credit for constructions of the ETH Domain (credit A202.0134) between the Annual Report of the ETH Board on the ETH Domain and the state financial statements for the period from 2018 to 2020.

In contrast, in the consolidated financial statements of the ETH Domain (see Financial Report www.ethboard.ch/financialreport2020), the federal contribution to accommodation (A231.0182: federal contribution to accommodation of the ETH Domain) which corresponds to a credit for the use of this real estate owned by the Federal Government.

Figure 31 shows the 2020 financial overview for the ETH Domain. The source and allocation of funds in the reporting period are explained in the following paragraphs.

Source of funds (income) in 2020

In 2020, the ETH Domain received credits amounting to CHF 2,596m. The federal financial contribution amounted to CHF 2,355m and the investment credit was CHF 241m. In addition, there are released dedicated reserves[1] amounting to CHF 30m which were available to the ETH Domain for dedicated investments in the real estate of the Federal Government. The release was approved by the Federal Finance Administration (FFA) in the reporting period.

The ETH Domain therefore received funds from the total federal contribution amounting to CHF 2,626m. Their share of total financing amounted to 71%.

The consolidated revenue from third-party funding amounted to CHF 1,093m. It came from project-oriented research contributions, donations, tuition fees and other income.

The total income of the ETH Domain in 2020 thus amounted to CHF 3,719m (total federal contribution of CHF 2,626m and revenue from third-party funding of CHF 1,093m).

Figure 32 provides an overview of the pro rata division of total income according to source of funds.

Revenue from third-party funding in 2020, which – unlike the income – is accrued to the period to which it belongs is commented on in detail in Objective 8 and in the Financial Report (see page 71 ff. and www.ethboard.ch/financialreport2020).

Allocation of funds (expenses) in 2020

The funds are used on the one hand for personnel expenses for teaching, research and administration, and on the other for operating expenses and investments in immovable property, plant and equipment, and movable and intangible non-current assets. The total expenses in 2020 amounted to CHF 3,653m. The previous year's reference value (CHF 3,553m) was exceeded by CHF 100m.

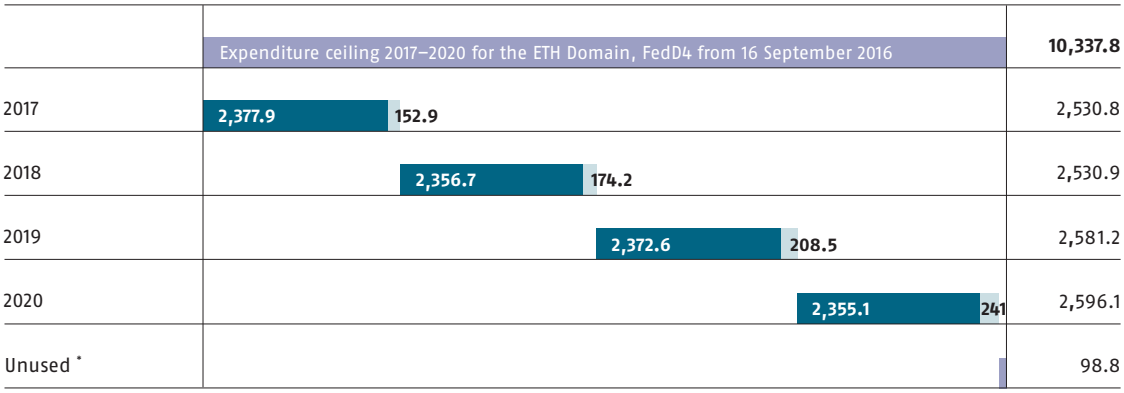
Figure 33 shows an overview of the pro rata distribution of total expenses according to allocation of funds for 2020.

Personnel account for the main share of the funds, whose share of the total expenses remained at last year's level of 65%. Investments increased to almost 16% of total expenses (2019: 13%) and contributed, together with the personnel expenses (which were also higher), to the increase in expenses. The amount of operating expenses and other expenses (2020: 19%, 2019: 22%) for infrastructure and projects in teaching and research depends on numerous factors (see Financial Report www.ethboard.ch/financialreport2020).

In 2020, the impact of the coronavirus pandemic emerged as the most important factor contributing to the decline in this expenditure category.

Fig. 30: Expenditure ceiling and loans for the ETH Domain in the ERI period from 2017 to 2020

CHF millions



* The utilisation of the expenditure ceiling (CHF 10,337.8m) amounts to 99%: credit funds amounting to CHF 10,239.0m were used.

A231.0181 Federal financial contribution
A202.0134 Investment credit for ETH Domain constructions

[1] Of the reserves of CHF 40.0m set aside in the Confederation as parent entity in accordance with Section 32*a* of the Federal Financial Budget Act (FBA) (see 2018 state financial statements), CHF 30m were appropriated in accordance with Section 35 FBA. In the 2020 state financial statements, this appropriation is recognised as a reversal by way of exceeding the overdraft at the Federal Office for Buildings and Logistics (FOBL) (VE 620) for credit A202.0134 Buildings in the ETH Domain.

Personnel expenses in 2020

The total of CHF 2,390m was CHF 84m higher than the reference value for 2019 (CHF 2,306m). In the reporting period, 19,644 full-time equivalents (FTEs; reporting date values) were financed, spread over 22,999 employment contracts (ECs) (2019: 18,983 FTEs). The additional expenditure on personnel was primarily a direct result of financing additional posts (+ 662 FTEs, + 4%). Part of the additional personnel expenses was used to compensate for inflation, to manage the payroll system and to increase employer contributions for pension provision.

The bulk of the financing for full-time equivalents is accounted for by the total federal contribution (2020: 12,607 FTEs). In 2020, CHF 1,700m was spent according to the statistical survey and is charged to the total federal contribution (federal financial contribution). The number of FTEs financed by the total federal contribution rose by 368 compared with 2019. The research contributions of the Federal Government and the EU FPs financed 4,776 FTEs. The funds stemming from cooperation with the private sector and from donations/bequests are allocated for 2,262 FTEs. Compared with 2019, there was a particular increase in full-time equivalents financed by research contributions of the Federal Government and the EU (+ 243 FTEs and + 5% respectively).

The employer contributions in relation to salaries and wages (not allowing for IPSAS 39) stood at 20.5% in 2020, which is the same as in the previous year. The 2020 budget calculations included a flat-rate employer contribution of 21.4% in line with Federal Government practice (Federal Office of Personnel, FOPER). The effective contribution rate for 2020 was thus lower than the contribution rate used for the calculation.

Investments

All investments are shown under the total investments, irrespective of ownership and their financing, i.e. they are the investments in the property used by the ETH Domain.

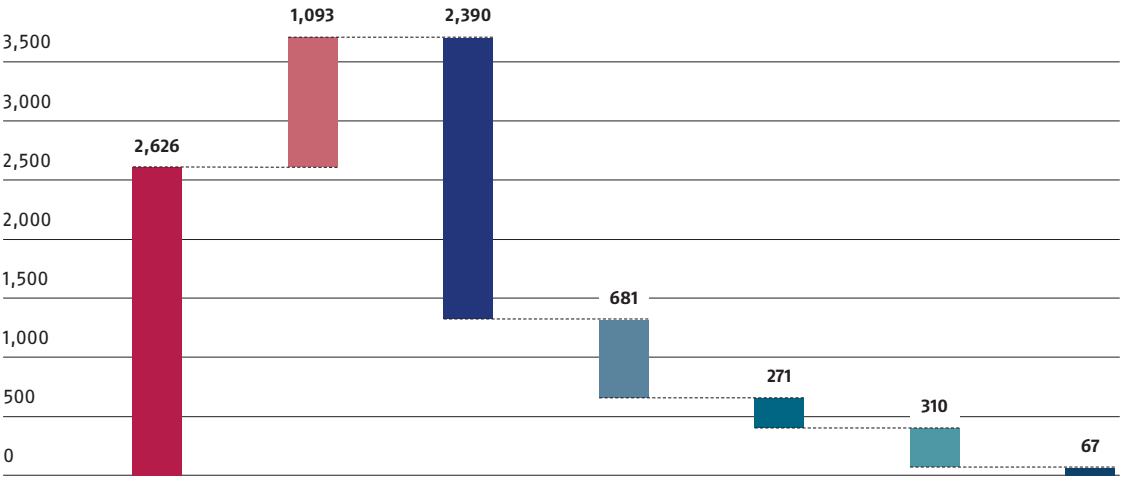
In 2020, significantly more was invested than in the previous year (2020: CHF 581m; 2019: CHF 474m). Development of the total investments is shown in Figure 34.

Investments have increased for two years in a row. The hike in expenses (+ CHF 107m) compared to 2019 is attributable without exception to the high level of construction activity in the reporting period, which continued even during the coronavirus pandemic. Other large investments in terms of amount related to the generally high investment expenses for leasehold improvements – above all at ETH Zurich – and, as in the previous year, the investments in the ATHOS beamline at the PSI.

The share of total investments, measured as a proportion of total expenses, was almost 16% and thus above the long-term average (approximately 12%), but within the usual range, compared, for example, with the central Federal Administration (12 to 15% share of total expenses).

Fig. 31: Income (CHF 3,719m) and the appropriation thereof

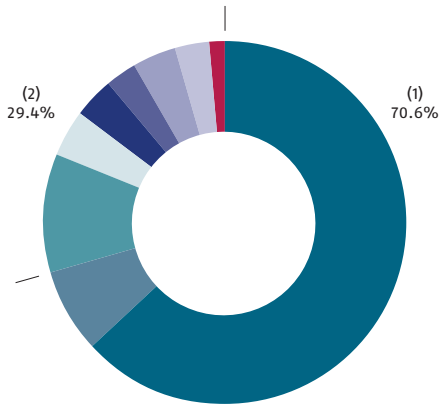
CHF millions



[1] The overall result (consolidated CHF 67m) was CHF 26m above the consolidated surplus according to IPSAS (CHF 41m), due to the effects of various accounting principles (essentially: accruement of income to the period to which it belongs, net pension obligations and the result of the associated entities)

Fig. 32: Source of funds
Structure of revenue in %

Total federal contribution and third-party funds: CHF 3,719m
(in a revenue-increasing manner)

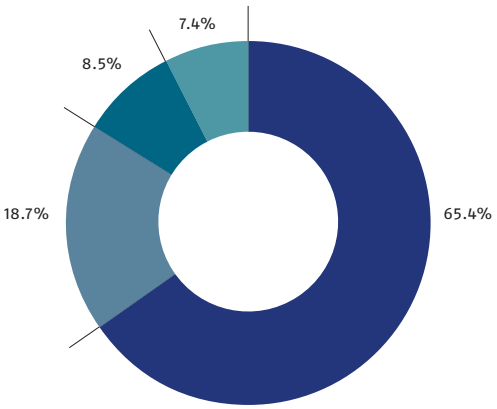


(1) Total federal contribution (in a revenue-increasing manner)	**70.6%**
Federal financial contribution	63.3%
Investment credit for ETH Domain constructions	7.3%

(2) Third-party funds	**29.4%**
Research contributions of the Federal Government:	10.7%
Swiss National Science Foundation (SNSF)	7.1%
Innosuisse	1.4%
Special federal funding of applied research	2.2%
Research contributions of the EU FPs	4.0%
Research contributions from cooperation with the private sector	3.7%
Research contributions, other project cooperation (cantons, universities, international organisations, etc.)	2.7%
Donations and bequests	3.9%
Other income	3.1%
Tuition fees, further education	1.3%

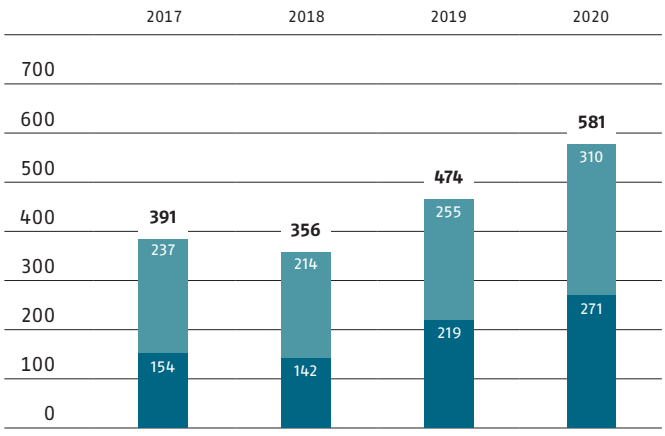
Fig. 33: Allocation of funds
Structure of expenses in %

Operating expenses, 2020 statement: CHF 3,653m



Personnel expenses	65.4%
Operating expenses and other expenses	18.7%
Investments in ETH Domain-owned properties	8.5%
Investments in government-owned properties	7.4%

Fig. 34: Development of the total investments (in CHF millions)



Consolidated financial statements

Table 1: Statement of financial performance of the ETH Domain (consolidated)

CHF millions	Notes	Budget 2020	Actual 2020	Actual 2019	Change to Actual absolute
Federal financial contribution		2,355	2,355	2,373	–17
Federal contribution to accommodation		244	244	244	1
Total federal contribution	**7**	**2,600**	**2,600**	**2,616**	**–17**
Tuition fees, continuing education	**8**	**48**	**50**	**48**	**2**
Swiss National Science Foundation (SNSF)		271	263	260	3
Swiss Innovation Agency (Innosuisse)		57	51	49	1
Special federal funding of applied research		79	80	82	–2
EU Framework Programmes for Research and Innovation (EU FPs)		153	146	152	–5
Industry-oriented research (private sector)		140	136	146	–10
Other project-oriented third-party funding (incl. cantons, municipalities, international organisations)		74	98	90	8
Research contributions, mandates and scientific services	**9**	**773**	**774**	**779**	**–5**
Donations and bequests	**10**	**100**	**142**	**92**	**50**
Other revenue	**11**	**122**	**114**	**140**	**–26**
Operating revenue		**3,643**	**3,680**	**3,676**	**4**
Personnel expenses	12, 28	2,445	2,490	2,386	104
Other operating expenses	13	1,008	885	935	–50
Depreciation	21, 23	234	255	267	–11
Transfer expenses	14	73	51	49	2
Operating expenses		**3,759**	**3,682**	**3,637**	**45**
OPERATING RESULT		**–116**	**–3**	**39**	**–41**
NET FINANCE INCOME / EXPENSE	**15**	**3**	**11**	**28**	**–16**
Share of surplus / deficit of associated entities and joint ventures	20	–	32	74	–42
SURPLUS (+) OR DEFICIT (-)		**–113**	**41**	**140**	**–100**

Table 2: Balance sheet of the ETH Domain (consolidated)

CHF millions	Notes	31.12.2020	31.12.2019	Change absolute
CURRENT ASSETS				
Cash and cash equivalents	16	1,968	950	1,018
Current receivables from non-exchange transactions	17	616	612	4
Current receivables from exchange transactions	17	60	48	12
Current financial assets and loans	22	464	1,430	–967
Inventories	18	10	10	–
Prepaid expenses and accrued income	19	63	49	14
Total current assets		**3,181**	**3,099**	**81**
NON-CURRENT ASSETS				
Property, plant and equipment	21	1,967	1,898	69
Intangible assets	21	62	63	–1
Non-current receivables from non-exchange transactions	17	971	939	32
Non-current receivables from exchange transactions	17	–	–	–
Investments in associated entities and joint ventures	20	242	208	34
Non-current financial assets and loans	22	52	42	11
Co-financing	23	118	123	–5
Total non-current assets		**3,412**	**3,272**	**140**
TOTAL ASSETS		**6,592**	**6,371**	**221**
LIABILITIES				
Current liabilities	24	189	154	35
Current financial liabilities	25	19	15	4
Accrued expenses and deferred income	26	151	150	1
Short-term provisions	27	108	102	6
Short-term liabilities		**467**	**421**	**46**
Dedicated third-party funds	29	1,608	1,555	53
Non-current financial liabilities	25	335	350	–15
Net defined benefit liabilities	28	1,087	2,423	–1,336
Long-term provisions	27	610	621	–12
Long-term liabilities		**3,640**	**4,950**	**–1,310**
Total liabilities		**4,106**	**5,370**	**–1,264**
EQUITY				
Valuation reserves		–27	–1,470	1,442
Dedicated reserves		1,468	1,365	103
Free reserves		778	856	–78
Co-financing	23	118	123	–5
Reserves from associated entities	20	242	208	34
Accumulated surplus (+) / deficit (-)		–93	–82	–11
Total equity		**2,486**	**1,001**	**1,485**
TOTAL LIABILITIES AND EQUITY		**6,592**	**6,371**	**221**

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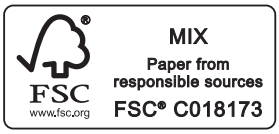
Rounding differences: the financial totals or figures presented in this document may not correspond precisely to the amounts shown in the tables. These amounts are calculated on the basis of non-rounded figures and may differ from a value based on rounded figures shown in the tables.

All photos of people for the reports in the chapter Fascination ETH Domain (p. 14–36) were taken in strict compliance with the measures relating to social distancing and the obligation to wear a mask, with the involvement of as few people as possible.

Special thanks are due to the following people for their contributions and involvement:
- all scientists in the ETH Domain's institutions in the preparation of the reports,
- the members of the ISP Group of the ETH Domain (Implementation Strategic Planning),
- the members of the ETH Domain ComTeam (Heads of Communication and their staff),
- the departmental heads and employees of the ETH Board staff and of the institutions of the ETH Domain, as well as
- the sawmill *Hobel- und Leimwerk Konrad Keller AG* in Stammheim for the opportunity to take pictures on their premises (p. 26).



ETH BOARD

The ETH Domain consists of the two Swiss Federal Institutes of Technology ETH Zurich and EPFL as well as the four federal research institutions, the Paul Scherrer Institute (PSI), WSL, Empa and Eawag. Appointed by the Federal Council, the ETH Board is the strategic governing and supervisory body of the ETH Domain.

www.ethboard.ch

The Institutions of the ETH Domain:

ETH Zurich
At ETH Zurich, approximately 500 professors educate around 23,400 students and doctoral students from over 120 countries. Together they are engaged in research in the fields of natural science, engineering, architecture, mathematics, system-oriented sciences, as well as in management studies and the social sciences. This knowledge flows into industries of the future such as cleantech, medtech or cyber security and forms the basis for more than two dozen new ETH spin-offs every year. Graduates on the degree programmes and further education courses use the knowledge they acquire at ETH Zurich to ensure that Swiss companies can compete globally.
www.ethz.ch

EPFL
EPFL is one of the most international technical universities. It hosts over 11,800 undergraduate students and doctoral students from over 120 countries. It has more than 370 laboratories conducting leading research in areas such as renewable energy, medical technology, neurotechnology, materials science and computer science. EPFL cooperates with an important network of partners, including representatives from other universities, industry and business, politics and the general public, in order to have a real influence on society. In 2020, a total of 25 spin-offs emerged from EPFL which equates to two per month. www.epfl.ch

PSI
The Paul Scherrer Institute (PSI) develops, builds and operates large-scale and complex research facilities, which it makes available for use by the national and international research community. All of these large-scale research facilities are unique in Switzerland, and in some cases the PSI is the only place in the world to have them. The institute's own research focuses on the fields of matter and materials, energy and the environment, as well as humanity and health. www.psi.ch

WSL
WSL investigates changes to the terrestrial environment and the use and protection of natural habitats and cultural landscapes. It monitors the condition and progress of forests, landscape, biodiversity, natural hazards and snow and ice, and develops sustainable solutions for socially relevant problems. WSL also includes the WSL Institute for Snow and Avalanche Research SLF Davos. www.wsl.ch

EMPA
Empa is the interdisciplinary research institute of the ETH Domain for materials science and technology. On the basis of its research, it develops solutions to meet the biggest challenges currently facing industry and society, and therefore plays a significant role in reinforcing the innovative capacity and competitiveness of Swiss industry in an increasingly competitive environment.
www.empa.ch

Eawag
Eawag is one of the world's leading water research institutes. Its strength and success are based on the combination of research, teaching and further education that it has provided for over 80 years, along with consultancy and the transfer of knowledge. The combination of natural sciences, engineering and social sciences enables comprehensive research into water in relatively untouched rivers and lakes, right through to waste water management systems.
www.eawag.ch

Cover page
The energy city of tomorrow – the architect Kristina Orehounig obtained a doctorate in building simulation and has been in charge of the Urban Energy Systems department at Empa for two years.

Title page "Fascination", page 11
During emergency operation, ETH Zurich Professor Kristina Shea and her team worked on the development of a new, low-cost ventilator for use in poorer countries.
› Nicola Pitaro/ETH Zurich

Back page
Martin Ackermann, Professor of Microbial Systems Ecology at ETH Zurich and Head of the Department Environmental Microbiology at Eawag has been the highly motivated and committed Chair of the Swiss National COVID-19 Science Task Force since 1 August 2020.

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