

EPFL 2021-2024 Strategic Plan



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PRESIDENT'S MESSAGE

I'm delighted to present you with our EPFL 2021-2024 Strategic Plan. This document outlines a set of ambitious priorities that will guide us over the next four years as we strive to achieve our vision and serve all sectors of our society.

This strategy lays out a number of broad objectives and initiatives that cut across boundaries and will transform EPFL. Our goals are threefold: to offer robust academic programs that are strategically important for EPFL, to promote excellence within these programs and to forge stronger ties among our schools and colleges.

The strategy was developed through a fully collaborative approach involving more than a hundred members of the EPFL community. We initiated the process over a year ago, in autumn 2018, when the EPFL leadership team – comprising EPFL's management and deans – held a series of planning sessions to pinpoint strategic initiatives that could enhance excellence within our School's core disciplines. The outcome of those sessions was presented for feedback at a meeting between EPFL's management and faculty in December 2018 and alongside my New Year's address to the EPFL community in January 2019.

Earlier this year, we set up nine working groups made up of EPFL stakeholders across all disciplines and levels to identify action items for implementing our initiatives. The working groups presented their ideas at the Journées Scientifiques et Pédagogiques in October 2019. The feedback gathered during this event has been incorporated into the nine strategic

initiatives you will find in Section 3 of this document. These initiatives are part of our broader strategy discussed in the other sections, which cover topics ranging from

Martin Vetterli,
EPFL President



digitalization, sustainability and research facilities to the strategic focus areas of the ETH Board and the strategies of our various schools and colleges.

I would like to thank all those who helped us prepare this important document for their hard work and dedication. The lively discussions we had with our various stakeholders were enlightening, and I look forward to our continued collaboration. I have no doubt that with the support of our talented faculty, staff and students, our vision for EPFL will become a reality – with achievements that we can all be proud of.

1. EXECUTIVE SUMMARY

Last year EPFL celebrated its 50th anniversary. This was an occasion for us to not only take stock of how far we have come, but also outline a clear vision for the path ahead. Under our 2021-2024 strategy, we intend to anchor EPFL as a driving force for education and innovation in Switzerland and as a major contributor to leading-edge research internationally. We will leverage the skills and intellectual curiosity of our faculty, staff and students to develop technology that delivers tangible benefits to society. And we will continue to work closely with business and industry in order to foster entrepreneurship, support the economy, and transfer our knowledge across our community.

For the 2021-2024 period, we have identified seven broad objectives essential to the success of our School: adapting our educational programs to meet society's needs; promoting the next generation of scientists and engineers; bolstering our research excellence in key scientific areas; promoting a culture of open science; deepening our relationship with the Swiss community; developing a sustainable campus and dynamic community; and further enhancing the sustainability and stability of our funding.

We have also identified six academic and three institutional strategic initiatives that span our various schools and disciplines and that will enhance our impact over the coming years. The six academic initiatives relate to energy and sustainability, the fundamental sciences, health science and technology, imaging, intelligent systems and neurotechnology. Our goal is to expand EPFL's research and teaching capabilities in these areas, create synergies through joint research and shared platforms, and strengthen our partnerships with businesses, other universities and university hospitals. The three institutional

initiatives relate to our PhD programs, campus culture and equal opportunity efforts, and will directly benefit the EPFL community. These strategic initiatives will be supported and complemented by the strategies of our five schools and three colleges.

Digitalization and sustainability will remain important focus areas under our 2021-2024 strategy. We will strengthen our leadership role in digitalization and help drive the digital transformation on several fronts, not just at EPFL but also at primary and secondary schools, high schools, vocational schools, continuing education programs, Swiss government agencies and local businesses. As regards sustainability, we aim to position EPFL as a benchmark university in integrated sustainability by embedding this topic into all aspects of our School – governance, education, research, innovation, our community and our operations. To this end, we will develop an EPFL-wide action plan with specific targets in all the areas mentioned above, along with deadlines for reaching those targets.

Last but not least, we will continue to play an important role in supporting the implementation of the ETH Domain's priority initiatives. We will work with ETH Zurich to further expand the scope of the Swiss Data Science Center, and our researchers will spur further advancements in each of the three other Strategic Focus Areas – Personalized healthcare & related technology, Advanced manufacturing and Energy – by providing their skills and know-how in education, research and innovation. In addition, we will leverage the expertise of the EPFL community to develop and operate our leading-edge research facilities, such as the Catalysis Hub (together with ETH Zurich), the Blue Brain Project platform and the Swiss Plasma Center.

2. OUR VISION

Science, technology and innovation are key drivers of change in today's society. EPFL, as a public university, will play a crucial role by:

- educating the next generation of responsible leaders
- contributing to the advancement of knowledge in critical areas
- effectively transferring knowledge to the society and the economy.

Studying for exams in the Rolex Learning Center library
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3. BROAD OBJECTIVES

To achieve our vision by 2024, we will focus on seven broad objectives over the next four years.

3.1. ADAPTING OUR EDUCATION PORTFOLIO TO MEET SOCIETY'S NEEDS

At the Bachelor's level, we will continue to provide a polytechnic education and instill the fundamentals of engineering. At the Master's level, this will be coupled with the skills required for a variety of careers in line with our society's needs. We will also further our efforts to encourage women to embark on careers in science and engineering and expand the Extension School offers.

Building on our achievements over the previous period (2017–2020), we will use an evidence-based approach to continue enhancing the scientific, engineering and architectural education we provide, and anchoring basic knowledge while preparing future graduates to face the challenges ahead in terms of lifelong learning and responding to societal issues.

Our Bachelor's curriculum will focus on giving students a solid polytechnic foundation that establishes a basis for continuous learning. Cross-disciplinary projects and courses on societal issues will be strengthened in order to equip students with ethical, management and teamwork skills. At the Master's level, we will emphasize hands-on projects and in-company internships to give students the practical skills and fundamental knowledge needed for the job market.

Studies at EPFL can be challenging, especially in polytechnic subjects. For students who require help in these subjects, we will reopen the Cours de mathématiques spéciales (CMS) to students with a Swiss high-school diploma, better preparing them for Bachelor's studies at EPFL.

For scientists, engineers and architects who want to further develop their skills after obtaining a Bachelor's or Master's degree,

we offer a range of continuing education programs, mainly through our Extension School. For instance, the Extension School runs Certificate of Open Studies (COS) programs that are open to participants of all backgrounds with no previous degree required (a first for an EPFL-certified program). The EPFL Extension School will continue to develop its curriculum offering to reflect in-demand, applied subjects, and to expand its individual training offers and enterprise training partnerships in order to reach a wide audience in Switzerland and beyond.

Under this new strategy, we will continue our efforts to encourage the young generation to embark on careers in science and engineering. Their skills and contribution will be essential for future research as well as for our economy and society as a whole. Our Education and Science Outreach Department will reinforce its efforts to get secondary-school students (and especially girls) interested in scientific and engineering fields, showing them the key role that scientists, engineers and architects can play in responding to global societal challenges. We started offering a series of Global Issues courses a few years ago that addresses these topics in particular. We are also working to incorporate these topics into all our degree programs, such as through semester or Master's research projects.

3.2. PROMOTING THE NEXT GENERATION OF SCIENTISTS, ENGINEERS AND ARCHITECTS

We will further promote the careers of young scientists, engineers and architects via doctoral programs and the tenure-track system.

The training and promotion of young academics is one of the core responsibilities of universities. EPFL's Doctoral School and our commitment to recruiting professors and helping them advance in their careers through a tenure-track system are major assets in fulfilling this mission.

Our customized doctoral programs are essential in attracting the best young graduates to EPFL and providing them with a skill set that makes them widely employable. We will continue to regularly review and improve our portfolio of doctoral programs and our PhD students' learning environment. Two specific areas of focus under our 2021–2024 strategy will be improving our conflict mitigation procedures and promoting a culture of responsible PhD supervision across our organization.

At the faculty level, we will further strive to offer our young, talented professors academic independence and the chance to take on managerial responsibilities that will enhance their long-term career prospects as early as possible. To this end, we will remain firmly committed to a flat hierarchical structure and a tenure-track system, which have become key elements of our organizational culture. To support young professors in their new responsibilities, we will offer them regular management training courses.

Finally, we believe that effective mentoring is of great importance to our young academics' success and advancement. As a result, we will reinforce our mentoring system for PhD students and for tenure-track assistant professors under our 2021–2024 strategy.

3.3. BOLSTERING OUR RESEARCH EXCELLENCE IN KEY SCIENTIFIC AREAS

We will strengthen EPFL's research excellence by promoting cross-disciplinary approaches that go beyond the traditional boundaries of disciplines. The range of disciplines we cover will remain broad, yet we will continually adapt this range to new developments in science and technology.

One key to EPFL's research success is our ability to explore fields of knowledge that exist at the crossroads of various traditional disciplines, such as between the life sciences and engineering or between materials science, chemistry and physics. These interactions are largely born of initiatives at the institutional level. Under our new four-year strategy, we will launch several other such initiatives in the areas of imaging, intelligent systems, neurotechnology and sustainability.

At the same time, we will further strengthen our core fields such as chemistry, mathematics, physics, or computer science. Our strengths in each of these fields are of paramount importance for two reasons. First, this is where the excellence of universities is often measured on an international scale. Second, each of these fields is responsible for one of the core programs offered by EPFL and the basis upon which young professors build their reputation.

We will also continue to enhance collaboration in targeted areas within EPFL, within the ETH Domain and with other institutions – not only in the Lake Geneva region but also nationally and internationally.

3.4. PROMOTING A CULTURE OF OPEN SCIENCE

We will remain a leader in the promotion of open and reproducible research, supporting the bottom-up adoption of best practices as well as the top-down development of research equipment and services.

The World Wide Web and digital technology are fundamentally changing how scientific knowledge is being produced and disseminated. Open science initiatives leverage this opportunity to make the research endeavor more transparent, reproducible, collaborative and inclusive – thereby further increasing its impact.

At EPFL, we are aware of the cultural change and leadership required to make open, reproducible research the norm. We stress our researchers' responsibility for excellence in managing research and disseminating results. We are committed to making open science a core tenet of our culture and to giving the students and researchers who join our organization the appropriate information and skills. Our priorities in this area include adopting best practices and providing the necessary support, tools and training opportunities through our library, our IT systems (including our high-performance computing facilities) and the other entities on our campuses.

Global research communities are best-placed to foster cross-disciplinary practices and standards. To support them, we are further expanding our facilities and services to facilitate the adoption of accepted practices for open science and to reinforce our role as a global hub for experimenting with new ones. We will address at an institutional level any contradictions between the benefits of open science and the criteria (perceived or real) used in research evaluation and career promotion.

We believe that researchers – not the facilities or service providers they use – must shape the future of open science. Our campus provides a forum where peers can discuss the different ways they view open science, and this dialogue will inform the strategic decisions we make and the services provided by our administrative and research staff.

3.5. DEEPENING OUR RELATIONSHIP WITH THE SWISS COMMUNITY

Through our scientific and technological capabilities, we will remain a key player in Swiss society, supporting its well-being, economy and security and helping deliver solutions to global issues.

We will continue EPFL's long tradition of carrying out joint research and innovation projects with industry and society and of supporting the entrepreneurial activities of our students and researchers. In promoting technology transfer and the uptake of the School's scientific discoveries by the public and private sectors, we are meeting our responsibility to make our research findings available to society, thereby ensuring our country's continued prosperity.

Under our 2021–2024 strategy, we will keep building strong national and international bridges with industry through bespoke partnerships with corporations and small and medium-sized enterprises (SMEs), as well as through our various cross-disciplinary R&D centers. Our satellite campuses in Neuchâtel, Geneva, Valais and Fribourg will play an important role in this objective. These campuses are closely linked to our teaching, research and innovation initiatives and have given rise to several R&D partnerships and synergies with other Swiss universities (such as the universities of applied sciences), cantons and local businesses.

We also intend to further expand the scope of our activities at EPFL Innovation Park, with a particular emphasis on diversity. Our Innovation Park has been highly successful and currently comprises 25 large companies and 120 startups. Now our aims are to further strengthen ties between

Innovation Park and our satellite campuses in western Switzerland and to advance collaboration within Switzerland Innovation Park Network West.

We will also pursue our ambitious strategy of establishing Lausanne as the center of a world-class startup ecosystem. If we are successful, the economic, technological and societal impact will be felt in Switzerland and beyond. We will keep promoting new startup initiatives designed to encourage innovation and facilitate technology transfer from our labs to society as a whole. So far, our School has spun off 293 startups – some of which have developed technology we use on a daily basis.

Furthermore, in line with our overall strategy to use our scientific and technological capabilities to address the major challenges of our time, our Enterprise for Society Center (E4S) and Tech4Impact initiative will seek to strategically expand our School's sustainability activities. By virtue of our location, EPFL is in a unique position to establish an open, inspiring platform that brings together a wide range of stakeholders – including students, researchers, NGOs, international organizations, politicians, corporations, entrepreneurs and the general public – to work together on innovative and entrepreneurial solutions with a scalable impact.

3.6. DEVELOPING A SUSTAINABLE CAMPUS AND DYNAMIC COMMUNITY

We will further expand our efforts to create a sustainable campus and an open, vibrant, and attractive community spread over several closely linked sites, each one rooted in its own ecosystem.

Part of EPFL's appeal is our dynamic campus and diverse community. We will continue to offer a stimulating working and learning environment, highlighting individual and collective contributions. We will invest in skills development through education and mentoring and continue to offer attractive employment conditions. We will strengthen our School's governance in accordance with our quality objectives and streamline our organizational structure where appropriate, while tapping into the constructive energy of the entire EPFL community.

We will further improve our campus infrastructure by renovating existing facilities and building new ones – like the Advanced Science Building, Discovery

Learning Labs (DLL) and other collaborative working spaces – in order to keep pace with growing needs and technological advancements.

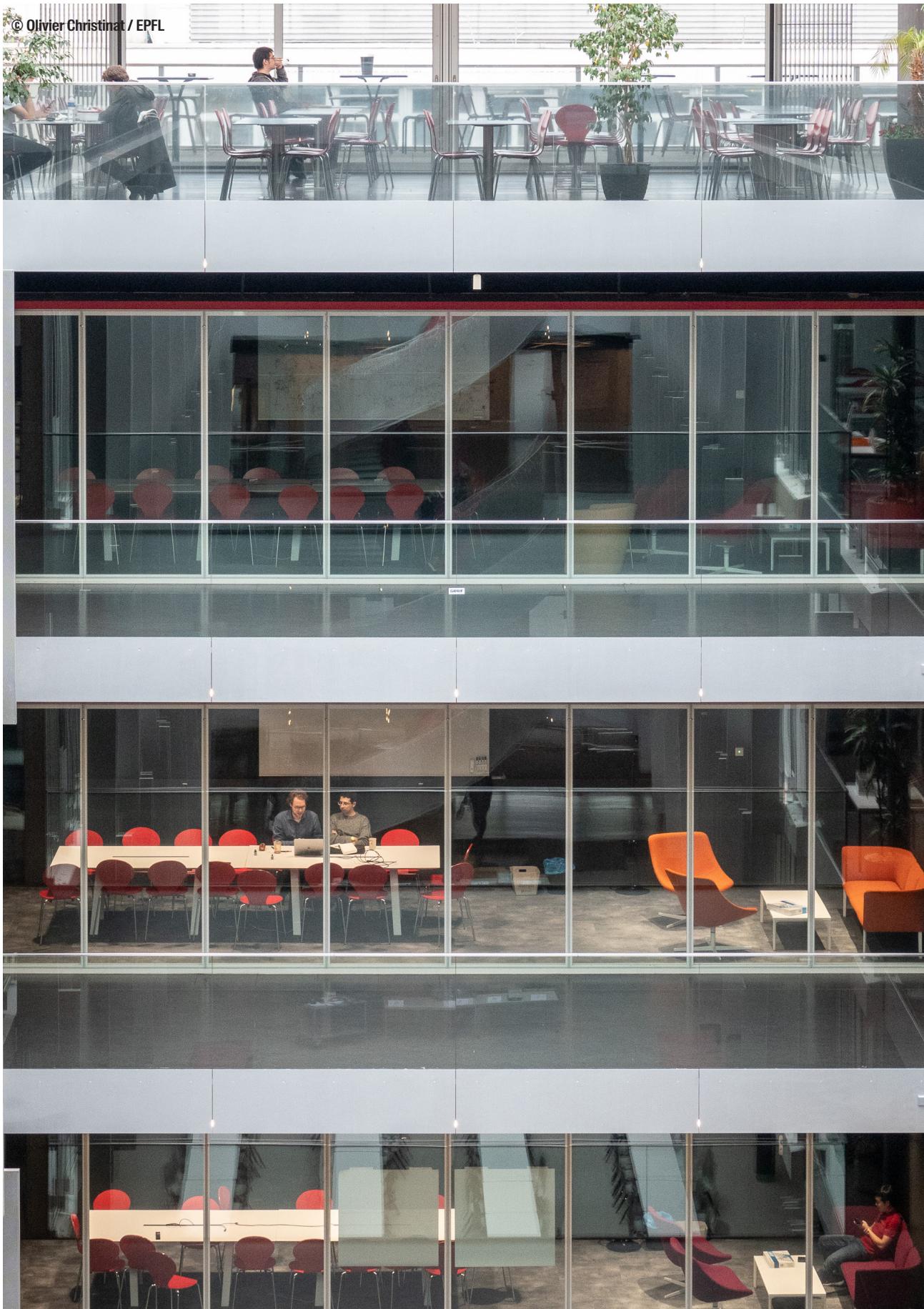
At EPFL, we are also deeply concerned by the climate crisis and are firmly committed to developing an impactful sustainability program. We want our School to serve as a model both in Switzerland and abroad in the field of integrated sustainability, encompassing our entire community, our missions and our organizational structure. As a true Sustainable Living Laboratory for our own research and innovation activities, we will quickly adopt the social and technological innovations necessary for our campus to support the environmental transition in an exemplary manner.

3.7. FURTHER ENHANCING THE SUSTAINABILITY AND STABILITY OF OUR FUNDING

We intend to reach critical size through controlled growth and sustainable finances.

After growing rapidly over the past 15 years and expanding our considerable international reach, we are now pursuing a strategy of reconciling growth, excellence and stable finances. As we seek a share of federal funding that is better aligned with our size and achievements, we will also continue our efforts to develop a variety of third-party funding sources for some of our chairs and strategic priorities. Maintaining and modernizing our research facilities will require major investments under our next two four-year strategies.

Cantonal partnerships, especially through our satellite campuses, represent key funding opportunities that we will pursue in the coming years. Another of our objectives is to step up our fundraising efforts, in part by continuing to engage our alumni network, in order to diversify our financial base. By strengthening our financial-planning, cash-management and budget-oversight processes, we will further enhance the sustainability and stability of our funding.



4. STRATEGIC INITIATIVES

To enhance our impact over the coming years, we will focus on the following nine academic and institutional strategic initiatives.

4.1. ENERGY AND SUSTAINABILITY

For Switzerland to be able to reach its 2050 energy strategy targets, scientists and engineers need to take a cross-disciplinary approach to developing new socio-ecological-technical systems (SETS). This will be one of the main goals of our strategy for the next four years, with targeted measures to position EPFL as a leading skills center for research and education on energy and sustainability. Our efforts are cross-cutting and innovative, and take into account not only energy systems and technology, but also infrastructure, businesses, governance, societal needs and acceptance.

Clean, affordable energy will be a key driver for a sustainable future and affect other UN Sustainable Development Goals (SDGs), such as: reducing inequality in general – and gender inequality in particular – in developing countries, improving citizens' health and well-being, promoting economic growth, building sustainable cities and communities and acting as responsible consumers and producers. As far as global warming is concerned, the most important step our society can take is to effect an energy transition. Major efforts are needed to switch our fossil-fuel-based economies to 100% renewable energy on a worldwide scale, across nations and industries, to prevent the global average temperature from rising more than 1.5°C.

Technological progress and innovation alone will not be enough for Switzerland to reach its 2050 energy strategy targets or its CO₂ reduction targets. We need to take a cross-disciplinary approach to developing socio-ecological-technical systems (SETS) if we want to address the deeply interlinked issues of energy, climate change and sustainability. Robust, cross-disciplinary research will be key to finding impactful

energy and sustainability solutions. This research should be cross-cutting and innovative and take into account not only energy systems and technology, but also infrastructure, businesses, governance, societal needs and acceptance.

To meet these new challenges, three types of opportunities lie before us: technological, SETS-driven and educational. The technological opportunities relate to (i) energy efficiency and materials usage (e.g., chemical processes, a circular economy, building technology and urban mining); (ii) energy harvesting, conversion, and use (e.g., waste-to-energy conversion via catalysis, solar energy conversion, and solar fuels); (iii) energy storage (e.g., liquid hydrogen batteries); (iv) carbon sequestration and valorization; and (v) integrating renewable energy into power grids through AI, IoT and/or blockchain technology. The SETS-driven opportunities relate to (i) behavioral change among producers and consumers; (ii) human-centered approaches and incentives to shaping individual choices, which are linked to large-scale automation processes; (iii) new methods for improving the acceptability and adoption of renewable

energy; and (iv) governance mechanisms for modular and decentralized “off-the-grid” energy systems, which are linked to power infrastructure and energy security. Additional opportunities can be found in the marketing and dissemination of new technology.

The educational opportunities relate to (i) incorporating sustainability into degree programs across all disciplines, so as to develop this core skill in future leaders; (ii) developing innovative, cross-disciplinary teaching methods that combine engineering and the social sciences and encourage critical thinking about global sustainability challenges; and (iii) improving students’ ability to leverage technological innovation by fostering student-led cross-disciplinary projects, with the goals of making EPFL the world’s most energy-efficient university campus and of producing zero waste.

Energy and sustainability are cross-disciplinary research topics at EPFL. Over 190 of our labs are performing research that addresses more than one SDG, and energy is a central research topic for about 25% of our research groups. Our main areas of expertise include renewable energy, energy conversion and storage, energy efficiency, smart grids, catalysis, sustainable mobility, housing, and the energy transition. Moreover, our School supports research and technology implementation (through initiatives such as Tech4Impact, EPFL Sustainability and EssentialTech).

Regarding our degree programs, we have introduced a new Master’s program in Energy Science & Technology, which provides an excellent avenue for teaching tomorrow’s energy engineers. However, our current range of sustainability-oriented courses is not enough to meet the growing demand for sustainability education. We need to roll out course modules of various formats for both students and teachers

so that we can offer courses specifically on sustainability and incorporate core sustainability concepts into curricula at all our schools.

To further position EPFL as a leading skills center for integrated research and education on energy and sustainability, we will (i) improve coordination, visibility and outreach, and leverage our research capabilities and ongoing achievements, (ii) forge closer ties among our research institutes and colleges and among the social sciences and engineering, (iii) improve our skills in experimental social science and crowd sourcing and (iv) strengthen the ties between energy and other sustainability fields. To that end, some of the measures we have planned include:

- using our main campus and satellite campuses as “living labs” to develop and implement sustainability-oriented initiatives in education, research, innovation and the energy transition.
- creating a long-term energy and sustainability platform where EPFL scientists and engineers can share research facilities, models and data, leverage existing competencies, bolster their competitiveness and respond to calls for proposals more quickly.
- establishing cross-cutting research hubs on specific topics to encourage cross-disciplinary research projects, and introducing seminar series on societal problems related to energy and sustainability (e.g., decentralized power grids, the circular economy and carbon-neutral manufacturing).
- improving our School’s visibility, outreach and collaboration through practice; this will enable us to leverage the knowledge developed in our research hubs, work more closely

with (and obtain funding from) key businesses, support the marketing of new technology (such as for the circular economy) and promote the application of research insights (such as through startups).

- further orienting education at EPFL towards sustainability by incorporating

this topic into new and existing courses, developing modules for lecturers and encouraging project-based learning through “living labs” (see above). We will also develop tailored sustainability modules for EPFL faculty, enabling lecturers to include sustainability concepts in their curricula.

4.2. THE FUNDAMENTAL SCIENCES

Any leading university that wants to have a lasting impact on science and innovation must cultivate substantial strengths in mathematics, physics and chemistry. The fundamental sciences were strengthened at EPFL 20 years ago, when they were transferred from UNIL, and we now plan to further increase and strengthen our activities in these areas. We will facilitate collaboration and knowledge advancement in these overarching research topics by supporting long-term programs that bring together several EPFL schools and by building the infrastructure that a cutting-edge university needs to conduct experimental research in the 21st century.

Any leading university today must have core strengths in the fundamental sciences. But if you try to pinpoint exactly what makes a science “fundamental”, you quickly end up with diverging viewpoints. For some, the fundamental sciences are characterized by curiosity-driven research that is fueled by scientists’ imagination and creativity. But it is also true that much groundbreaking research in the fundamental sciences is inspired by a desire to develop important applications, to better understand the world around us, or to find answers to the challenges of modern society.

Research in the fundamental sciences often shows its value on a much longer time scale than that for the applied sciences and engineering. Therefore, to advance the fundamental sciences at EPFL, we should focus not on current topics or trends, but rather on priorities and initiatives that attract the most creative, innovative researchers. This includes offering conditions and opportunities that allow them to pursue long-term research

efforts across a variety of fields as part of a collaborative organizational culture.

Breakthroughs in fundamental sciences often occur at the crossroads of two or more traditional fields or by combining traditionally disparate methods within the same field. Therefore, we must prioritize the hiring of individuals who adhere to such a collaborative, dynamic approach, and we should facilitate their efforts by creating an environment that provides the right intellectual support and research facilities.

EPFL is well-placed to do this in many ways, as we have numerous local hubs of outstanding research in the fundamental sciences across all our schools. To better seize these opportunities and leverage the resulting synergies, we have a number of initiatives planned to expand our intellectual capacity by promoting new modes of collaboration and enhancing the quality of our facilities, making them ideally suited for performing cutting-edge research in the fundamental sciences.

Intellectual capacity: We have identified several overarching research topics that are anchored in the fundamental sciences and have the potential to catalyze collaborative, interdisciplinary research projects. These topics include: Theoretical Sciences, Fundamentals of Complex Systems, Theoretical Foundations of AI, Quantum Science and Engineering, and Global Change. They span the research areas of at least two EPFL schools, with substantial existing but often disconnected research activities, and can bring clearly identifiable benefits to enhance collaboration across EPFL.

We plan to facilitate collaboration and knowledge advancement in some of these topics by supporting long-term, interdisciplinary research programs that involve several EPFL schools. Such programs will be anchored in the schools' fields of research and will aim to create forums and academic incentives for EPFL researchers to engage in activities in one or more of these topics. We will invite internationally renowned scholars to EPFL to take part in the programs and spend time at EPFL as visiting resident scientists, so they can actively participate in and enhance the programs' activities. This approach will seek to balance the benefits of short-term visiting scholar programs with those of permanent positions at research institutions. In addition, because these programs will be long term in nature, they will be well-aligned with the

timeline inherent to fundamental science. We will review the programs periodically so as to ensure dynamic, timely research opportunities.

Research facilities

While these proposed long-term research programs should expand our activities across the fundamental sciences and spur new collaborative initiatives, they must be accompanied by investments in the requisite equipment and facilities, including:

- An advanced sciences building: To enable research in a number of fields critical to EPFL's continued growth and excellence in the fundamental sciences, we need a new building dedicated to advanced experimental research. This building should meet the specifications for high-quality research facilities.
- Laboratories for conducting research under the new collaborative programs in fundamental sciences: For the new research programs to be successful, scientists from several schools will need suitably designed meeting rooms and laboratories where they can conduct joint experiments. International experience confirms that this is an essential component of successful collaborative research involving several disciplines.

4.3. HEALTH SCIENCE AND TECHNOLOGY

The increasingly technical nature of evidence-based and precision medicine is creating an opportunity for well-trained scientists, engineers and digital specialists to work with doctors to develop technology that improves patients' lives. At EPFL, we intend to train the next generation of cross-disciplinary healthcare scientists and engineers and build additional bridges with medical degree programs. Through our state-of-the-art research programs and research centers, we will bring together the different areas of expertise at our School and leverage the synergies among them.

Healthcare has become increasingly specialized with the introduction of evidence-based medicine, which is now evolving into precision medicine. This change is being driven by scientific, technological and digital breakthroughs. New “-omics” technology (such as genomics, proteomics and metabolomics), as well as advancements in multimodal imaging, robotics, digital health and artificial intelligence, has left many doctors ill-prepared to embrace the latest medical solutions. As a result, specialized engineers, scientists, public-health workers and IT specialists have become the experts in these fields, and they often assist doctors. However, even these experts find it hard to keep up with the rapid pace of technological change. Furthermore, the healthcare industry will soon have to cope with major societal trends in the areas of demographics, sustainability, inequality, environmental change and digitalization. Doctors and scientists alike should therefore become more familiar not only with the technological aspects of healthcare, but also with new developments that have an impact on these societal issues.

This is where EPFL can make a major contribution by educating the next generation of physician-scientists and healthcare technology experts. This will entail, first, bringing together competent scientists and engineers from across the School to work on healthcare-related research; and second, creating a research center for healthcare science and

technology, a platform where scientists, engineers, IT specialists, AI specialists, healthcare economists and clinicians can perform joint R&D.

EPFL's current approach to healthcare science and technology is not fully coherent. The School of Life Sciences does not cover all aspects of this field; it has only four healthcare-related institutes, which are focused on cancer research (ISREC), infectious diseases (GHI), the brain and mind (BMI) and bioengineering (IBI). Other EPFL schools also have excellent programs, but they are not sufficiently integrated across our organization. Many large fields for healthcare research remain uncovered: biochemistry, cardio-metabolism, inflammation, immune systems, pharmacology, human genetics, medical technology, digital opportunities for public health and healthcare economics. Building this expertise at EPFL will be difficult, but our partnerships with local experts can help fill those voids.

All this means there are major opportunities to be explored. As mentioned above, we initially plan to create a center for research in healthcare science, technology and economics, where basic scientists from our different schools will work with clinicians, public-health specialists from Lake Geneva-area hospitals and the WHO, and biotech and medtech engineers. More specifically, the center will:

- leverage EPFL's broad scientific know-how, with the support of all our schools

- strengthen partnerships with the region's main hospitals such as CHUV, HUG and Inselspital
- train the next generation of cross-disciplinary healthcare scientists and engineers
- build additional bridges with medical degree programs so that our students can seamlessly transition into medical programs, giving the next generation of physician-scientists the necessary knowledge to implement new technology for the benefit of their patients
- strengthen ties with the biopharma and medtech industries
- engage with public health officials and organizations (like the WHO) and health economists.

Ideally, the center will be the first step towards opening an institute for healthcare science and technology. This institute will bring together researchers, state-of-the-art technology platforms and local businesses, and have enough lab space for those businesses (which will range from big pharma companies to biotech, medtech and AI startups) to perform joint R&D. Our center will not be intended to replace medical schools, but rather to supplement their teaching and research with technology-oriented programs. These programs would not entail launching a full medical degree program at EPFL, since we can already draw on our partnerships with CHUV and HUG.

4.4. IMAGING

Imaging plays a central – and expanding – role in science and engineering, all the way from the nano to the macro level. We believe that future progress in this field will stem largely from joint research and cross-fertilization among various disciplines, and that machine intelligence will become increasingly prominent. We therefore plan to promote cross-disciplinary imaging research and encourage shared tools, facilities and resources. We will also build new research capabilities and facilities for the development of increasingly advanced technology and methods.

The role of imaging in science and engineering is fundamental and set to grow further. It lets researchers view and quantify physical processes and see the internal 3D structures of objects and biological samples with unprecedented resolution in both space and time. Advanced imaging technology usually draws on several disciplines since it requires careful sample preparation, sophisticated instruments (involving physics and sensors) and elaborate data processing for reconstruction and analysis. The payoff in terms of scientific discovery can be huge, as demonstrated by the recent

Nobel prizes awarded for advancements in super-resolution microscopy (2014) and cryo-electron tomography (2017, with a major contribution from a Lausanne-based scientist). Today the main trends in imaging include developing increasingly powerful instruments; generating imaging data in space (often 3D) and time, which requires advanced data storage and analysis capabilities; and improving the interaction and interdependence between physical instruments and computer algorithms. This latter trend has given rise to the field of computational imaging, where software forms an integral part of imaging

instruments. Computational imaging is being incorporated into most imaging methods today (including X-ray, magnetic resonance, acoustical imaging and optical imaging).

Due to the widespread use of imaging and its reliance on many different kinds of technology, it harbors great potential for new developments across all disciplines. The most pressing needs are related to incorporating machine learning into imaging paradigms, so as to generate better reconstructions and make it easier to run quantitative analyses; performing faster and higher-resolution imaging; producing images while taking fewer measurements (or using a lower radiation dosage); performing adaptive imaging with on-the-fly data processing; and using imaging data for personalized medicine. Another priority area is applications-oriented development, such as for digital healthcare and vision-based manufacturing, which can also be a vector for technology transfer to Swiss businesses.

At EPFL, we have a large, diversified population of scientists (biologists, physicists and computer scientists) and engineers who are involved in imaging technology – all the way from the nano to the astronomical scale – for a broad range of applications (e.g., remote sensing, medical imaging, cellular and structural biology, computer vision and AR/VR). Many of our scientists and engineers have made renowned contributions to the advancement of imaging methods and instrumentation – such as by developing better imaging sensors (e.g., CCDs, SPADs and PET scanners), next-generation microscopes and advanced algorithms for reconstruction and analysis – and have conducted pioneering work in machine learning. Our School is equipped with advanced imaging facilities (BIOP, CIME, CIBM and PIXE) that support researchers

in many fields by providing assistance with and access to cutting-edge technology. We also offer a range of imaging-related courses that include hands-on training (on biomicroscopy and image processing, for example).

Although our research disciplines boast many strengths and have much in common, there is still considerable scope for improving collaboration and cross-fertilization. Imaging technology is progressing rapidly, meaning we must regularly update our research facilities, which can be rather costly. Our imaging facilities (except for the CIBM) are purely service-oriented, which is not ideal for staying at the top of our field and for enabling consistent use of the latest technology. Imaging hardware alone is not enough to obtain reliable quantitative information; we also need image-processing and data-processing software – two fields that often lie outside the areas of expertise of the scientists who use our instruments. In addition, not everyone has access to long term data-storage platforms that are compatible with open-science standards. And in terms of imaging-related courses at EPFL, they tend to be scattered across our different schools.

We therefore plan to consolidate our imaging activities at EPFL with two complementary aims: (i) speed scientific discovery by enabling faculty to work together and by promoting cross-disciplinary research projects, and (ii) upgrade our shared imaging infrastructure, including both software and data storage platforms, so as to enhance our core facilities.

The cornerstone of these efforts will be our existing imaging facilities, which will be given a greater role in supporting research. They will act as hubs for cross-disciplinary projects and as vectors for advancing imaging research at EPFL.

Specific measures we plan to take include:

- hiring world-class faculty members specialized in imaging science, whose expertise closely matches our existing imaging facilities (the goal here will be to extend our current activities beyond the state of the art)
- getting our faculty more closely involved in core facility operations (this will include setting up a steering committee to oversee operations, introducing mechanisms to facilitate the transfer of new developments across our facilities and building up our network of users)
- upgrading our imaging equipment and forging closer ties with the imaging industry (through test sites and technology transfer)
- setting up the Dubochet Center for Imaging – a joint initiative with the universities of Lausanne and Geneva – to house state-of-the-art equipment
- providing additional assistance with image analysis and data management so as to help researchers using our equipment (in particular with large-scale data generation, quantification methods and open science)
- introducing mechanisms (e.g. seed funding and calls for proposals) for fostering collaboration and cross-fertilization
- developing an imaging technology curriculum, and supporting joint Master's projects with co-supervisors.

4.5. PRIVACY AND INTELLIGENT SYSTEMS

One transformation driving major research and innovation today is the merging of the virtual and physical worlds through the development of autonomous and intelligent systems. To help further this transition, EPFL has created a new center bringing together researchers working on various aspects of intelligent systems.

A key driver of change today is the fading border between the virtual and physical worlds, thanks to the development of autonomous and intelligent systems such as wearable technology, robotic coworkers and assistants, smart devices, drones, augmented reality, smart infrastructure, smart transportation systems and many other artificial-intelligence based applications. Such systems are having a growing impact on the way we live and work, and they will likely have far-reaching implications for societal issues – including employment, education, safety, and privacy – as well as ethical and legal ramifications. As intelligent systems become increasingly widespread, they will give rise to at least four challenges:

- They will bring about radical change in many areas including manufacturing, transportation, retail, employment, healthcare, government, legislation, security, privacy and education.
- They will require new design paradigms, given that intelligent machines and humans must work together to accomplish goals and, possibly, share the same physical space. Issues related to safety, reliability, control, explainability, accountability and responsiveness will thus become paramount.
- They will give rise to a new layer of interconnected and intelligent

systems. Scientists and engineers will need to address a whole new set of challenges in order to design complex interconnected systems with a ‘mind’ of their own. We are already seeing rudimentary elements of that in cyber-physical systems. However, much more will be needed to account for the intelligence factor, which will become pervasive.

- Due to their increased level of interconnectedness and autonomy, intelligent systems will give rise to an array of new ethical and legal issues that will require careful consideration.

Unlike automated systems, which are programmed to perform repetitive tasks within well-defined boundaries and control procedures, autonomous and intelligent systems can learn from experience and from humans. They can actively search for information, make decisions in complicated situations they have never encountered before, move out of geographically restricted areas, repair and sustain themselves and, eventually, work with humans and share the same physical space. In the future, manufacturing, healthcare, environmental monitoring, energy and transportation systems, not to mention large-scale research facilities, will rely heavily on autonomous robots capable of operating in complex environments alongside humans, responding to changing constraints, and working in new frontiers (as in space and extreme environment exploration).

Building such systems requires drawing on competencies from many different fields that are sometimes grouped under the term AI: data science, machine learning, vision and speech technology, audio processing, natural language processing, integrative intelligent systems, cyberphysical systems,

human-AI collaboration and planning. Mathematics, statistics and theoretical computer science are also critical to the foundations of AI, whose underpinnings are still shaky.

EPFL is currently a major, but not sufficiently visible, player in this field. We recently set up a Center for Intelligent Systems that brings together researchers working on different aspects of “smart” technology. This center will undoubtedly help build awareness of intelligent-system research on campus, leading to greater cross-fertilization among scientists and engineers and more fruitful collaboration. Under our 2021–2024 strategy, EPFL’s various schools will work together through the center to:

- create additional, targeted faculty positions in the emerging discipline of applying computational intelligence to technological, engineering and societal challenges and to building human-machine systems. A focus on building such systems is essential for an engineering school like EPFL and will provide a framework for cross-disciplinary collaboration.
- establish a common, shared platform for research.
- develop courses to teach various aspects of intelligent systems across our degree programs and schools.
- perform outreach activities to make our efforts better known elsewhere in Europe and beyond.
- develop close, productive ties with Swiss industry.
- support Switzerland’s digitalization initiatives.

4.6. NEUROTECHNOLOGY

The convergence of neuroscience, engineering, and artificial intelligence is creating a unique opportunity to address 21st-century challenges related to the study of the brain and the development of advanced therapies so that people can live better, healthier lives.

Our upcoming EPFL-wide initiative called Neuro-X will strengthen our position as a leader in all neuro-related fields and create a unique ecosystem for basic and translational research, providing a broad, leading-edge education in neurotechnology and promoting innovation and technology transfer.

Neurotechnology – one of the most dynamic and promising research areas of the 21st century – draws on all critical, fundamental disciplines of science and technology to develop methods for better understanding, regulating and repairing the human nervous system. Organizations around the world, including governments, major institutions, research agencies and businesses (both medical and non-medical), have launched research and education initiatives in this field.

EPFL has a unique, diversified neurotechnology ecosystem involving faculty members and state-of-the-art research facilities, giving us considerable potential for innovation. Neurotechnology research at EPFL is focused on two main areas that feed into each other: technology-driven neuroscience and neurotechnology for medicine and society. The first uses fundamental science and scientific discovery to obtain a better understanding of the nervous system – from genes and molecules to motor and sensory circuits and cognition – while the second is engineering-driven and develops systems for translational research and improved health and well-being. Both areas benefit from mutual knowledge-sharing.

We currently have over 50 faculty members performing neurotech research at our schools of life science, engineering, computer science and basic science. Our expertise ranges from applied

mathematics and cognitive neuroscience to neurophysiology, gene therapy, robotics, biomaterials, machine learning, imaging and advanced manufacturing. One of our main research goals is to better understand the motor and sensorimotor systems so that we can design effective therapeutic interventions.

We also provide the local scientific community with state-of-the-art research facilities that cover advanced computing, simulation, imaging, animal research, manufacturing and characterization. Our Campus Biotech is emerging as a catalyst for neurotech research at EPFL and the broader Lake Geneva region, in applications such as simulating the human brain (through the BBP), conducting translational research (through the CNP) and promoting innovation, with the Wyss Center serving as a translational accelerator.

EPFL is part of a regional neuroscience network (through NeuroLeman) and contributes to joint initiatives for carrying out translational and clinical research in the Swiss Health Valley (through HUG, CHUV and Clinique Romande de Réhabilitation-SUVA). Our international network includes organizations and universities such as Harvard Medical School, and our faculty members play an active role in transferring technology to startups and interacting with the local medtech and neurotech industries.

To unlock the full potential of our unique ecosystem, we will launch an EPFL-wide initiative called Neuro-X with the unifying goal of using research and education to address 21st-century challenges related to neuroscience. By improving cohesion and collaboration across our dynamic, multidisciplinary community, Neuro-X will advance our understanding of the human brain, harness biological and artificial intelligence, drive technological breakthroughs, and translate those breakthroughs into scalable diagnostic and therapeutic systems for people with neurological disorders and mental illnesses. Proposed measures under the initiative include:

- creating an overarching EPFL Neuro-X Council. The Council will oversee neurotech communication and branding for our School, hold joint events and develop and coordinate large, cross-disciplinary research projects. It will also serve as a bridge between EPFL, our clinical partners and the Wyss Center.
- identifying the main neurotech challenges our School can address. The Neuro-X Council will promote knowledge sharing and communication across disciplines and groups to identify priority areas of cross-disciplinary research that build on, and expand, EPFL's strengths. The Neuro-X initiative will in particular build on the accomplishments of the Blue Brain Project to further enhance, by osmosis with other theoretical and experimental neuroscience approaches, our fundamental understanding of the healthy and sick brain and design new therapeutic interventions to diagnose, prevent and treat neurological and mental illnesses. Support funding for new professorships and collaborative research projects will be needed to implement these concrete measures.
- improving cohesion on our campus and beyond. Neuro-X will help improve communication and research partnerships among Campus Biotech, EPFL's main campus, EPFL satellite campuses and local organizations. The Council will outline a strategy for performing translational research, including research on non-human primates, and set up a framework for facilitating joint efforts between our faculty and leading clinical scientists, physicians and therapists.
- reviewing the neurotech-related courses offered at our School. We will perform an in-depth assessment of upcoming business and research needs in neurocomputation, neuroscience, and neuroengineering and, based on our findings, develop a proposal for an extended educational offer in neurotechnology.
- delivering responsible innovations to improve neurological care. To that end, Neuro-X will implement measures to enhance our school's legal and ethical expertise in this field; educate project leaders, researchers, and students; develop educational tools; and hold scientific conferences to address the potential technological impact of our research and the societal issues that could arise.

4.7. DOCTORAL SCHOOL 2.0

We have around 2,200 PhD students enrolled in our 21 doctoral programs. While a recent survey showed high satisfaction levels among doctoral students, it also identified three areas of improvement that will be addressed under our 2021–2024 strategy: helping PhD students build more effective relationships with their advisors and mentors; reducing depression and stress levels among PhD students; and providing additional career development skills and prospects for doctoral program graduates.

Our approximately 2,200 PhD students are all registered and supervised in our 21 doctoral programs. Each PhD student has an EPFL thesis director, and many have a co-director, i.e., someone from the academic or non-academic sector who holds a PhD. These thesis directors guide PhD students academically and help them develop and advance their career plans. Our doctoral programs offer both scientific and technical courses and facilitate PhD students' academic and social integration. For instance, our programs include mentoring by academic staff members and keep tabs on students' progress yearly. Our Doctoral School oversees the various programs' operations, coordinates courses on transferable skills, and holds social events for the scientific community (such as international summer schools).

During the 2018–2019 school year, we carried out a comprehensive survey of PhD students and obtained more than 1,000 responses. The survey results were favorable compared with several well-known foreign universities, with EPFL students reporting high satisfaction levels. However, the survey results also revealed that we need to make some improvements. Respondents cited gaps, for example, in student-advisor relationships, support for handling stress and depression, and career preparation. What's more, they said that the balance they must strike between being employee-subordinates on the one hand and student-researchers on the other has been shifting too much towards the former.

In order to remain at the forefront of doctoral education and supervision, we will take the following targeted measures to address these areas of improvement:

- **PhD student-advisor (and mentor) relationships:** We will improve the onboarding of professors and PhD students. Tenure-track professors should be given additional support and EPFL-specific management training (such a program has already begun). Our PhD welcome event will be reviewed and possibly updated, and it will be made compulsory for all incoming PhD students. In order to effectively manage expectations, we will create a guide for PhD students and advisors covering the main academic and HR-related rules as well as guidelines for supervising PhD research. It will take the form of a short, easily readable online booklet that will be regularly updated. Our aim will be to strengthen our PhD communities and hold more doctoral-program events giving PhD students an opportunity to meet and talk with program directors, thesis advisors and mentors, thereby improving supervisory relationships.
- **Depression and stress levels among PhD students:** The measures mentioned above for improving PhD student-advisor relationships should help in this area as well. However, another important measure we plan to introduce is mandatory exit interviews with all PhD students who

leave their program before graduating; these interviews will be conducted by doctoral program directors. We will also further develop and communicate procedures and contact points for avoiding and handling difficult situations between PhD students and their advisors. EPFL's Respect Unit will be positioned as the main contact point for reporting the more serious and problematic situations. PhD students will be given more freedom to choose courses (scientific, technical and transferable) as well as more courses to choose from, in order to better align their curricula with their research and career plans. We will make the core values of taking initiative, exploring new ideas, critical thinking and independent decision-making a part of each PhD student's education. And we will start sending out a newsletter every two months for all PhD students and advisors, with regular highlights such

as PolyDoc events, alumni and career events, and reminders of certain rules and regulations.

- **Career preparation for PhD students:**

PhD students need to be able to make better-informed decisions about their career goals (and, in fact, our society needs more high-level scientists to become leaders). We will aim to improve our PhD students' ability to communicate to broad audiences, lead teams and manage projects. An EPFL PhD program should take four years to complete (extensions should be exceptional). We will start holding an annual PhD career event and require that PhD students include a section on their career plans in their third-year reports. Another measure we are considering is a fund for international academic or non-academic exchange programs of several months each that PhD students could apply for.

4.8. POSITIVE CAMPUS CULTURE

While we already offer attractive employment opportunities and working conditions at EPFL, more can be done to support professional development, employability and mobility throughout our organization and across the ETH Domain. Steps we will take in this area include providing additional training on leadership and management skills, introducing an EPFL-wide HR policy and prioritizing equal opportunity in hiring.

A critical issue for our School's continued development is being able to attract and retain top talent, whether in administrative, technical or scientific positions. More specifically, we need to foster an environment conducive to employees' personal and professional development. Most quality employers (in Switzerland and internationally) offer appealing professional development and career prospects along with a commitment to equal opportunity, and these factors are becoming increasingly important differentiators in the job market.

The paradigm for leadership and management has changed considerably. Employees now expect their managers, including professors, to provide them with a stimulating environment in which they can work efficiently and develop professionally. Leaders are faced with similar expectations, but with the additional challenge of navigating their organizations through highly complicated, demanding environments. This requires leadership and management skills commensurate to the task.

At EPFL, we offer attractive employment opportunities and working conditions, including a stimulating work environment. Whereas the career path for professors is clear and well-defined, more can be done to support staff members – academic and otherwise. By facilitating their professional development, we will benefit the entire EPFL community. This is even more important given that our staff work in a fast-changing environment requiring flexibility, the capacity to embrace change and the skills to communicate effectively. Our employees must continually acquire new competencies, be it to meet new demands, take on new responsibilities or maintain employability.

We first identified the need to strengthen our management skills in 2017, and this was added to our HR strategy as a priority focus area. Our HR department accordingly developed a management training program specifically for new tenure-track assistant professors, which was introduced in February 2019 as a mandatory part of their new employee orientation program. A first cohort of 20 such professors is currently completing the program and has given us positive feedback regarding its relevance and effectiveness. We also ran a pilot management course for non-academic managers; the course proved successful and will now be scaled up to address the needs of a larger target group.

The high retention rates across our organization, along with the high degree of specialization required in some professions

(like for scientists and technicians), mean that employee mobility has long been a priority at EPFL. Our HR department provides in-placement or out-placement support to employees when their research unit or laboratory closes or restructures, as well as training in transferable skills such as project management. Yet we can still do more to support professional development, employability and mobility throughout our organization.

We therefore plan to introduce the following key measures to enhance our existing staff management efforts:

- develop the next generation of leaders, which will entail identifying and preparing tomorrow's academic and non-academic leaders through a tailored joint program
- give managers the skills they need to manage effectively by extending our management training courses to all professors and managers at our School
- develop a clear EPFL-wide HR policy for junior faculty members who have been hired on open-ended contracts
- develop a program to identify high-potential administrative and technical staff and support their professional development, based on an assessment of priority needs (we will also look into options for better supporting these staff at our various schools and research centers).

4.9. EQUAL OPPORTUNITY

We will step up efforts to hire and retain female professors, increase our intake of female students, foster an educational and working environment conducive to equal opportunity and increase the percentage of women in managerial and leadership positions.

Promoting equal opportunity and instilling respect for diversity are core elements of our organizational culture and will be cornerstones of our 2021–2024 strategy. The concrete measures we plan to take in this area consist of:

- ***Stepping up efforts to hire and retain female professors.*** We plan to significantly increase the number of female professors we hire, with a target of at least 40% of new job offers being made to women. This will entail proactively searching for and engaging with a diverse pool of excellent candidates, continuing our efforts to reinforce awareness of the implicit biases we often hold – and how we can mitigate their impact on our hiring procedures – and improving the accountability and monitoring of our results in this area. These measures are outlined in our guidelines on equal opportunity in faculty hiring and in our dual-career policy. We have carried out a study of the status of women faculty members at EPFL; the findings will help us develop additional measures for ensuring that EPFL remains capable of hiring and retaining top professors and supporting them in their tasks.
- ***Increasing our intake of female students and achieving greater gender balance in our degree programs (Bachelor's, Master's and PhD).*** This is already a core objective of four of our units (Science Outreach Department, Education Outreach Department, Science Promotion Department and LEARN center), but under our 2021–

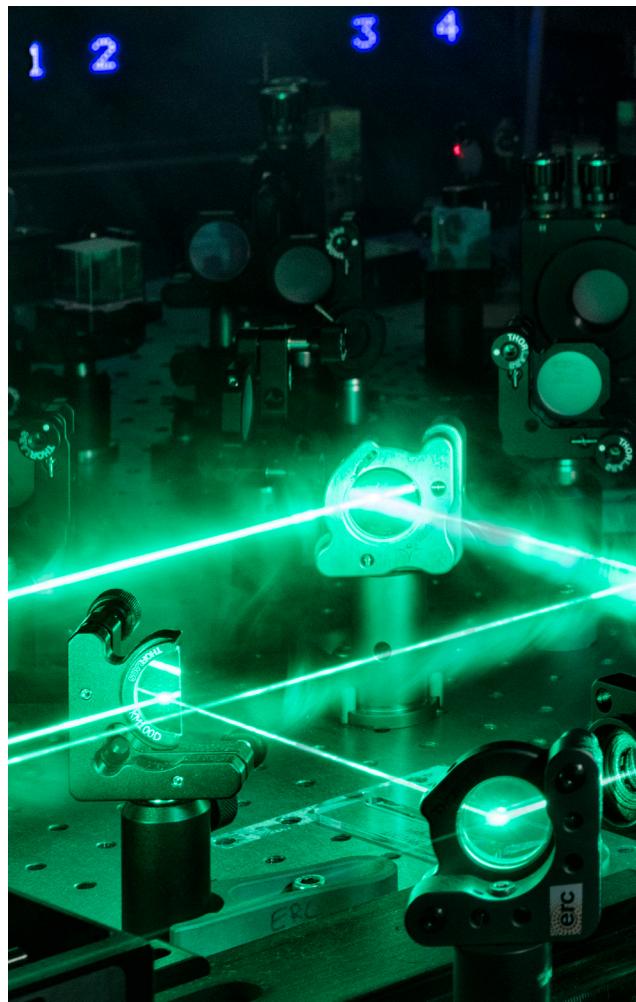
2024 strategy, we will mainstream their efforts across our organization and work with policymakers and other schools and stakeholders to outline specific actions we can take jointly.

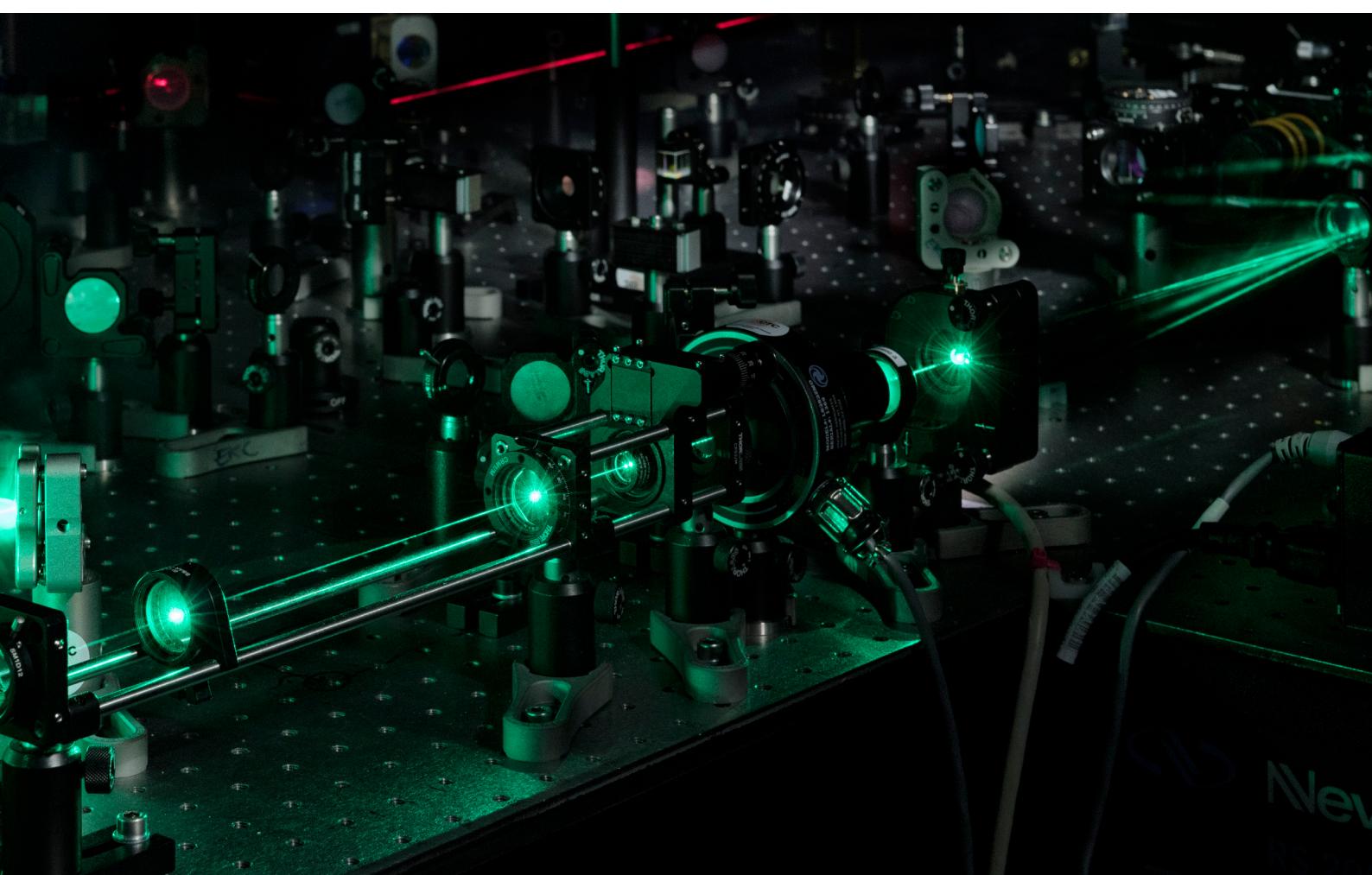
- ***Fostering an educational and working environment conducive to equal opportunity.*** Efforts made under our 2021–2024 strategy will focus on:
 - > Promoting respectful, supportive conduct and a diverse community: we will build upon existing measures such as our Respect Unit to implement targeted communication and awareness-building campaigns addressing our entire School. The focus will be on early-stage prevention and conflict resolution. These activities will be carried out by dedicated EPFL units in association with other EPFL community stakeholders.
 - > Enhancing measures to support staff and students seeking a better work-life balance: we already introduced a series of measures under our 2017–2020 strategy to help our staff and students achieve a better work-life balance; these include expanding our campus daycare services, providing emergency child care, introducing a Stop-the-Clock policy for PhD students and postdocs, and launching the Robert Gnehm Grant for postdocs with young children. Under our new strategy, we will further these measures, assess them on an ongoing basis, and supplement them

with targeted improvements based on the needs of the EPFL community. We will place particular emphasis on providing adequate information and support to students and staff (including unit heads and lab directors).

- Providing more attractive career prospects and professional development opportunities. Until now, our efforts for promoting career development and gender equality have mainly addressed PhD students and postdocs. Under our 2021–2024 strategy, we intend to pursue these efforts, continually assessing them and supplementing them where needed with actions focused on promoting equal opportunity. In addition, we will introduce measures to enhance the career prospects of administrative and technical staff, improve the gender balance in all professions at EPFL and increase the percentage of women in managerial and leadership positions.

Our new policies for promoting equal opportunity will build on our existing framework, although we will implement additional targeted measures that will be described in more detail in our 2021–2024 action plan.





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5. DIGITALIZATION

5.1. DIGITAL SKILLS

The advent of digital technology and its implications for society are forcing us to consider how we can leverage these advancements to improve our way of life. As a public university, EPFL has a leading role to play in preparing current and future generations to navigate the digital transition.

In terms of education, digitalization is having three broad impacts:

1. **Impact 1:** digitalization is changing the content we need to cover in our courses, and more specifically the

skills we should impart to students, such as programming, computational thinking and critical thinking (e.g., to spot fake news).

2. **Impact 2:** digitalization is requiring us to adopt new teaching methods and tools.
3. **Impact 3:** digitalization is requiring us to update how we manage educational institutions, especially in light of recent advancements in data science.

Our School has emerged as a leader in these issues thanks to the specific research centers and other resources we have set up. We have set the following strategic orientations for responding to the digital transition, broken down by educational level.

At the university level

We have substantially increased the number of courses that cover elements of computer science (and especially artificial intelligence) in recent years. This increase was implemented quickly and in a targeted manner to meet the needs of students and their future employers. To address impact 1 above, we need to ensure that digitalization concepts are taught in each of our degree programs so that our students receive appropriate training in this field, are well-prepared for their careers, and are equipped to adapt to future transformations. Our Master's programs in Data Science, Cybersecurity, and Digital Humanities serve this purpose particularly well.

In 2013, we opened the Center for Digital Education (CEDE), which manages a fund for developing digital tools for learning and teaching, in order to address impact 2. So far these tools have been aimed primarily at giving students basic knowledge during their first years of study. Going forward, the focus will be on creating tools specifically for teaching the fundamental concepts of science and engineering. The CEDE – together with the LEARN center opened in 2018 - also provide services for encouraging the use of digital resources and conducting experiments on a broader scale. One example of these digital resources is our Learning Companion app, which helps students adopt good learning habits. Other resources will be developed to provide more – and more personalized – feedback to students (such as through automatic correction and skills diagnoses).

Finally, to address impact 3, the CEDE rolled out the Campus Analytics project to help implement and evaluate a data-based educational system. The goals are to assess the latest innovations in teaching and create decision-support tools for the various stakeholders in educational systems. The Center is currently putting together an anonymous educational dataset that will be made available to researchers in order to promote the use of machine learning and artificial intelligence for educational applications.

At the high-school level

We draw our student base from graduates of Swiss high schools. In October 2017, the Swiss government decided to make computer science a mandatory subject in all the country's high schools starting in 2022. At EPFL, we are helping high schools implement this decision by working with them to draft new curricula (to address impact 1), develop new teaching tools (impact 2) and train new teachers (impact 3). In these efforts, we will work jointly with other cantons whenever possible.

At the primary- and secondary-school level

EPFL has long been involved in educational robotics, which includes training teachers on how to use robots in the classroom, especially in primary and secondary schools. The LEARN center helps these schools and the educational departments of different cantons to incorporate digital skills and technology into their official curricula. Our approach is based on applying the technology developed in research labs to improve daily teaching practice. The aim is to use experimental research findings to enhance modern teaching methods (i.e., evidence-based innovation in education). LEARN addresses all three of the digitalization impacts discussed above. For impact 1, the center identifies which computer science concepts (especially computational thinking) can be taught at

an early age (kindergarten) with the help of adapted teaching methods. For impact 2, LEARN researchers are developing digital tools that can provide concrete help to teachers. And for impact 3, the center is coming up with ways to better manage teacher communities and educational projects that support the digital transition at the institutional level.

At the vocational training level

We are conducting research on educational technology that can be used specifically for vocational training programs, such as augmented reality and social platforms that bridge the gap between theory and practice. This is being done through numerous partnerships with industry associations, schools and Swiss government agencies (cantonal and federal) that run vocational training programs. EPFL has set up a collaborative platform on this issue, with funding from the Swiss State Secretariat for Education, Research and Innovation (SERI). Over the next eight years, the platform will conduct research on the digital transition in education and bring together all stakeholders: schools, the Swiss Federal Institute for Vocational Education and Training (SFIVET), the Swiss Universities of Teacher Education (HEP), the Swiss Conference of Cantonal Ministers of Education (EDK), and industry professionals. This collaborative effort will focus on the three impacts mentioned above, with the aims of (i) identifying the skills now expected by companies wishing to adapt to the digital era; (ii) collecting experimental data on the effectiveness of educational technology specific to vocational training; and (iii) showing decision-makers how data-science methods can help them manage their institutions more effectively. To translate this research into practice, the platform will work closely with the Swiss EdTech Collider, which is an innovation hub on the EPFL campus involving more than 80 edtech-industry startups.

At the continuing education level

As the modern workplace becomes increasingly digital, half of all employees will have to update their digital skills at some point in the near future. Our EPFL Extension School, launched in 2017, aims to help workers adapt to the digital era and seize the many opportunities it offers, through a variety of courses for participants of all ages and educational backgrounds. The courses cover not only digital technologies but also programming and data science. We believe that with the appropriate training and support, anyone can speak “digital,” “code” and “data” – and the wide range of profiles of individuals successfully learning with the EPFL Extension School strongly confirms this belief.

EPFL Extension School courses are given entirely online, and include personalized feedback for participants and one-on-one video sessions with instructors. Knowledge acquisition is assessed through practical, applied project work that learners must complete and present to teachers by video conference. This fully online approach, combining individual work with one-on-one support and concrete outcomes demonstrating learner mastery, has already enabled our Extension School to enhance the digital skills of hundreds of professionals across Switzerland.

Going forward, the EPFL Extension School will continue to develop its curriculum offering to reflect in-demand, applied subjects, and to expand its individual training offers and enterprise training partnerships in order to reach a wide audience in Switzerland and beyond.

5.2. DIGITAL TRUST

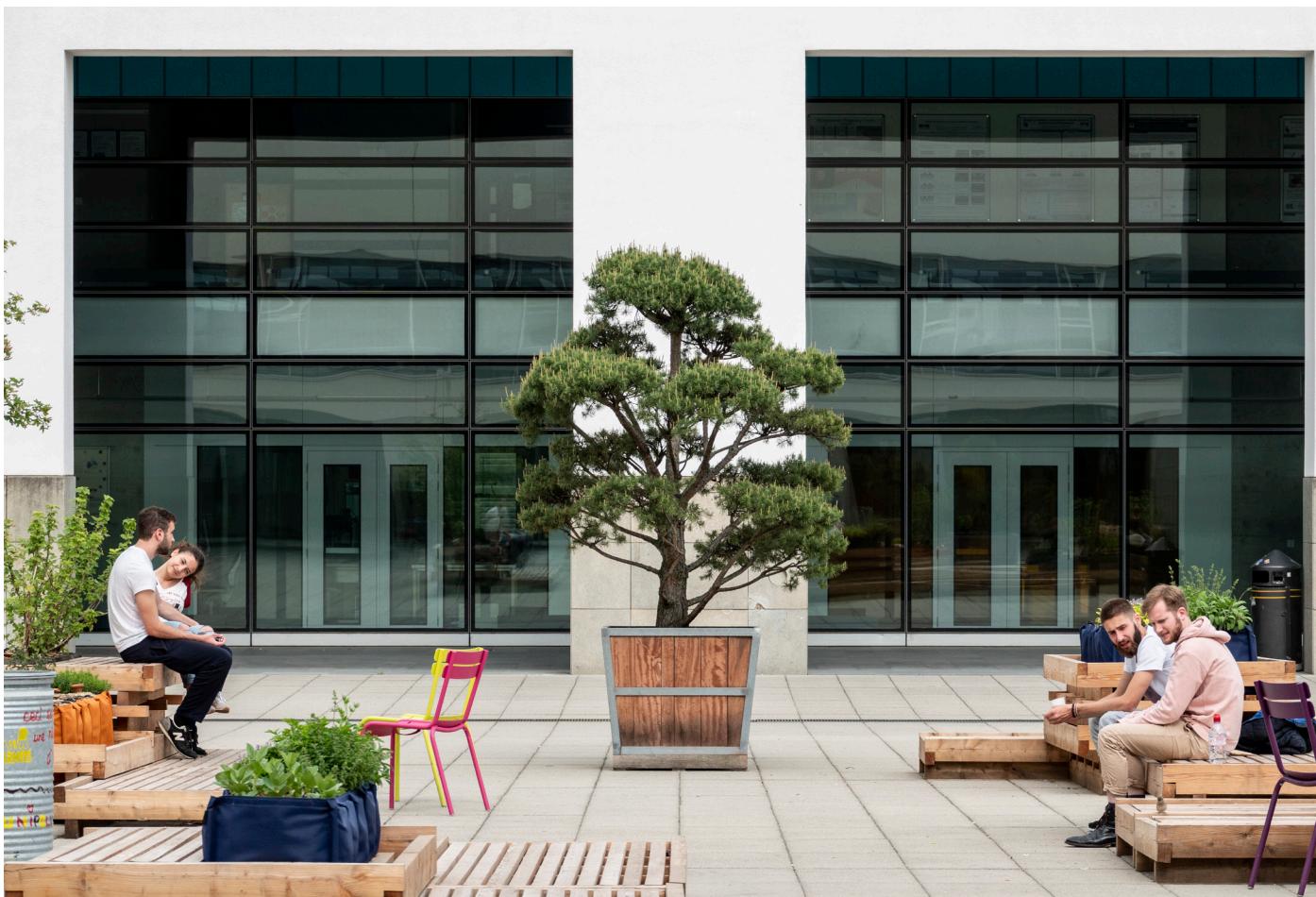
For millennia, humans have been developing trust-building mechanisms among people, businesses and governments for society to function. These mechanisms include languages, social norms, legislation, diplomacy, authoritative bodies and institutions. Today, those trust mechanisms need to be transposed into the digital world; otherwise, low levels of trust – caused perhaps by data breaches or malicious usage – could hinder the deployment of digital technology. If we want modern society to benefit from the opportunities being offered by the digital transition, we need to create a technological, legal and ethical framework that provides strong guarantees, can be applied universally and reduces the cost of earning digital trust.

A crucial factor in achieving these goals will be making sure that digital technology is rolled out in a safe, secure way (with high levels of transparency and personal data protection), both in Switzerland and internationally. In Switzerland, the government has introduced four strategic initiatives: a digital action plan, a cybersecurity strategy, a cyberdefense strategy and a Swiss data-security network. Other recent developments – such as the Swiss Digital Initiative, the CyberPeace Institute, and the Libra Association (all based in Geneva), along with Microsoft's Defending Democracy Program on electronic voting – are giving us a clear opportunity to scale up the four strategic initiatives to an international level and

position EPFL at the center of a dynamic, growing ecosystem.

Our School is home to the Center for Digital Trust (C4DT), an alliance of businesses and universities that aims to facilitate innovation in digital-trust-enhancing products and services. C4DT has international reach, bringing together businesses, EPFL laboratories, members of the general public and policymakers to collaborate, share insight and obtain early access to the trust-building technology being developed at EPFL and elsewhere.

C4DT will have two key priorities under the 2021-2024 strategy. First, it will facilitate technology transfer and make sure that Switzerland remains competitive on the issue of digital trust by giving stakeholders access to EPFL-developed software, raising awareness among decision-makers and building a community around the topic. Second, it will advocate effective policies at the national and international levels, positioning EPFL as a global benchmark. To that end, we will work closely with Swiss government agencies (cantonal and federal) on the four strategic initiatives mentioned above (in part through a joint cybersecurity support center in Bern operated together with ETH Zurich), contribute to international initiatives and foundations (such as the CyberPeace Institute in Geneva) and foster collaboration with other universities in Switzerland (such as UNIGE, UNIL and HEID) and abroad.



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6. SUSTAINABILITY

Transitioning from the current modus operandi to a sustainable one is probably the greatest challenge facing the global community in the 21st century. Universities – and schools of science and engineering in particular – should serve as natural catalysts in this transition owing to their unique role in generating the skills, knowledge and entrepreneurship needed to address this challenge. However, fulfilling this role will entail expanding their scope: in addition to their longstanding missions of education, research and innovation, universities must seek cross-sector partnerships with the general public, policymakers and businesses to jointly develop sustainable solutions that respond to societal needs.

At EPFL, we have long recognized our responsibility towards the global community, especially with regards to the environment. We have expanded our research and teaching capabilities in fields such as renewable energy, green chemistry and sustainable living, and we actively promote sustainability at our campuses – primarily through the Sustainable Campus initiative we rolled out in 2007. Projects under this initiative include building the largest urban solar power plant in Switzerland, with a surface area of 15,500 m²; upgrading our heating system to use only lake water for heating and cooling (it will be fully operational in 2021); encouraging green transportation, with the result that today over 80% of EPFL commuters use

low-carbon or public transportation; running a pilot project to reduce air travel by EPFL employees and establish a set of travel guidelines; and launching a sustainable food strategy that entails using more locally produced food and washable dishes for all take-away lunches on campus. Recently, the farmland owned by UNIL and EPFL was made available to a young collective in order to grow fruit, vegetables and trees and breed farm animals through a sustainable, closed-loop system. The farm's products will be sold directly on site and on the EPFL and UNIL campuses. These are just a few of the many steps we are taking as a responsible steward of our environment.

Given the scale and complexity of the sustainability challenge facing our society, we intend to step up our efforts over the next few years and position our School as a benchmark university in integrated sustainability. By serving as an example both within Switzerland and internationally, we will not only uphold our mission as a public-sector university but also enhance our own organization. The goal is to embed sustainability in all aspects of our School: governance, education, research, innovation, our community and our operations. More specifically, we will:

- set up the right systems and processes to foster a sustainability-oriented culture
- incorporate sustainability topics into the curricula of all our degree programs, so that students have the skills they need to be responsible leaders and address key environmental and societal issues
- leverage the expertise of our scientists and engineers to accelerate the development of innovative technology with concrete applications, primarily through cross-disciplinary research projects
- promote mechanisms for spurring

technological innovation, particularly in the field of environmental protection, and for transferring that technology to society either through the creation of startups or by facilitating widespread adoption

- enhance knowledge-sharing among scientists, engineers, economists, the general public and policymakers
- reduce and offset our CO₂ emissions in order to help meet the goals of the Paris Climate Agreement and the Swiss government's climate strategy (i.e., a 50% reduction in CO₂ emissions by 2030 relative to 2006 levels).

In addition, we recently set up a task force composed of faculty members, staff and students who will work together to outline a roadmap for making our campuses more sustainable. This task force will develop an EPFL-wide action plan with specific, measurable targets in all the areas mentioned above along with deadlines for achieving those targets under the aegis of the new vice-presidency for responsible transformation.



7. STRATEGIC FOCUS AREAS OF THE ETH DOMAIN

7.1. SWISS DATA SCIENCE CENTER

Today we are seeing a growing need for a national applied-research center – one that would serve as a platform for providing research services, encouraging joint projects with organizations beyond the ETH Domain and pooling the resources of all Swiss universities. The goal would be to provide data-science and artificial-intelligence facilities, tools and services to university researchers as well as businesses and the public sector. Such a center would also foster excellence in cross-disciplinary data-driven research, disseminate best practices in FAIR (findability, accessibility, interoperability and reusability) data and in open science, and promote open innovation.

EPFL's Swiss Data Science Center (SDSC) is ideally suited to play this role. It sits at the crossroads of business and academia,

drawing on a vast network and solid reputation in Switzerland and beyond. Under our 2021–2024 strategy, the SDSC will step up its data-science and artificial-intelligence research collaborations within the ETH Domain and form cross-disciplinary partnerships with other Swiss universities. It will expand existing joint research projects, initiate new discussions with universities abroad and further extend the use of its FAIR-data and open-science platforms (including RENKU) to national and international universities and businesses.

In its partnerships with industry, the SDSC will encourage the use of data science by showing the beneficial impact it can have in specific areas, while managing expectations on both sides. It will jointly hire and guide junior data scientists in accordance with a full cost recovery model.

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It will also help disseminate knowledge in data science by taking an increasingly active role in continuing education, training, and coaching programs for professionals in industry and academia.

To help reach its goals, the SDSC will issue joint calls for proposals with other Swiss organizations (such as swissuniversities and the Swiss National Science Foundation) for large-scale, data-driven,

cross-disciplinary research projects that adhere to FAIR data principles. It will also further strengthen its ties with businesses and university research labs across Switzerland. One aim will be to turn existing joint projects into long-term strategic partnerships. Another will be to introduce an executive education program, in order to keep playing an important role in higher education initiatives at the national level.

7.2. PERSONALIZED HEALTH AND RELATED TECHNOLOGY

Healthcare is being revolutionized by technological breakthroughs in life science, engineering, computer science and communications. While this presents a number of formidable opportunities, it also comes with a fair share of challenges. At EPFL, we aim to help address these challenges through our Health 2030 initiative, launched in conjunction with the universities of Geneva, Lausanne and Bern and their affiliated hospitals. The initiative is a multicentric, cross-disciplinary program designed to explore the potential of new technology for delivering personalized healthcare and precision medicine. Health 2030 is part of the ETH Domain's Personalized Health and Related Technologies (PHRT) initiative and the Swiss Personalized Health Network (SPHN), which was created to promote the development of personalized healthcare systems in Switzerland.

Precision medicine entails generating, interpreting and cross-comparing large data sets obtained through "omics" analyses (such as genomics, proteomics and metabolomics). In 2017, the ETH Domain opened the Health 2030 Genome Center as part of its PHRT initiative. The Center serves as an international hub for clinical-grade genomic analyses and leverages genetics- and genomics-related synergies

among scientists, clinicians and the general public. It is becoming a leading institute for high-throughput sequencing in Switzerland, making the best technology and analytics systems available to all Swiss clinical and research organizations.

One clinical service provided by the Genome Center is the fast-turnaround sequencing of tumor samples, which is becoming an essential tool for doctors to identify a tumor's molecular characteristics, establish a prognosis and choose the best course of treatment, whether drug- or immune-based. It works closely with the Swiss Cancer Center Leman (SCCL) to provide this service.

The Genome Center, in association with the Clinical Proteotype Analysis Center (the PHRT Proteomic Platform), based at ETH Zurich, has created a Swiss "omics" research pipeline that will help anchor our country at the forefront of precision medicine. A pilot project has already been completed where the combined PHRT Platforms generated a multi-omics data set in record time from a cohort of around 230 young patients with a rare kidney disorder.

EPFL is involved in several other personalized healthcare initiatives in Switzerland; we are helping to develop national strategies, carry out several joint research projects and promote two other skills centers in precision

medicine by hosting the Swiss Data Science Center (SDSC) and the SCITAS high-performance computing cluster.

7.3. ADVANCED MANUFACTURING

Under the ETH Board's 2017-2020 strategy, we furthered our efforts to develop a skills center in advanced manufacturing, initially drawing on ETH Board funding for this Strategic Focus Area. EPFL labs are taking part in nine of the eleven advanced-manufacturing projects selected during two calls for proposals (one in 2016 and one in 2017), and lead three of them.

The Strategic Focus Area funding we received has been used for a variety of objectives. They include setting up an additive manufacturing platform; hiring an engineer from the University of California, Berkeley, to head the Advanced Fabrication Technology Laboratory at EPFL; and hiring a director in October 2018 to set up and manage the Micro-Manufacturing Science and Engineering Center (M2C). This center

provides engineering and management resources for businesses and universities to conduct research in advanced micro-manufacturing, the miniaturization of high-precision components and integrated systems with embedded intelligence.

Under the 2021-2024 strategy, M2C will expand its partnerships and acquire additional additive-manufacturing equipment in order to expand its know-how and offer a broader range of services to the microengineering industry. EPFL as a whole will continue its efforts in advanced manufacturing and actively participate in joint R&D projects in this field. Regarding our degree programs, the microengineering section will develop a new study plan that fully incorporates advanced manufacturing concepts.

7.4. ENERGY

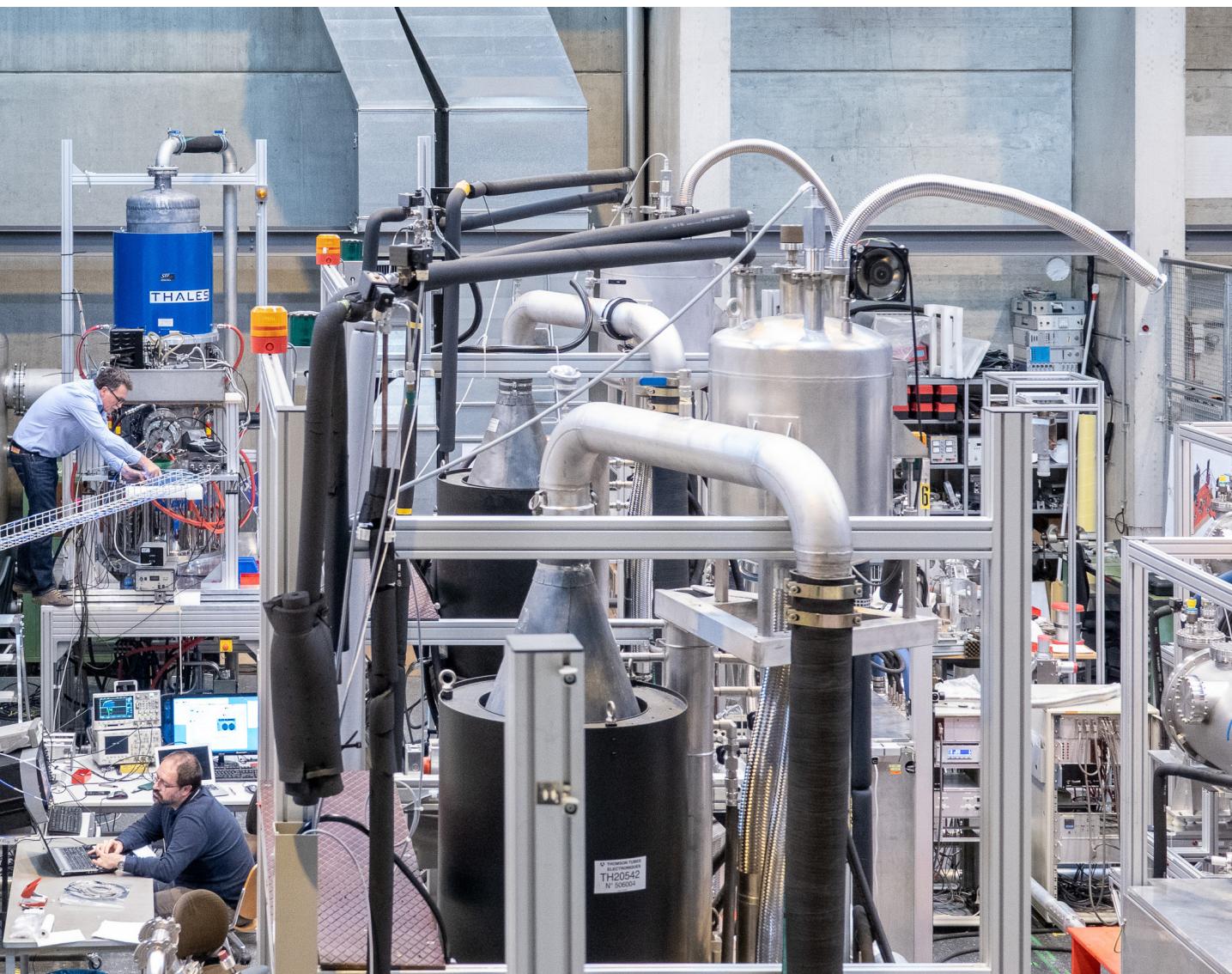
The three factors driving today's energy transformation are digitalization, decentralization and decarbonization. Modern climate and energy policies require the extensive use of renewable energy, often with the additional constraint of securing a country's energy supply. This is further complicated by the fluctuating nature of renewable-energy generation systems and of demand for power. That makes it difficult to operate power grids efficiently and effectively. On the positive side, the energy transition is creating new opportunities in education, research, and innovation, from both an economic and academic perspective.

In response, we will consolidate EPFL's world-class standing in this field, building on our excellence in education, our technological development capabilities and our mechanisms for transferring knowledge to industry and society through effective pilot projects. We introduced a new Master's program in Energy Science and Technology that teaches students how to tackle present and future energy challenges, whether they decide to pursue careers in industry or academia. Students in the program can choose from three specializations: energy conversion devices, energy systems, and energy management and sustainability. The program includes lectures by EPFL's

internationally renowned professors as well as hands-on lab experience at our state-of-the-art research facilities.

Our school is home to several highly-ranked scientists – in fields such as materials science, plasma physics, computer science, data science and energy systems – who conduct advanced research on energy technology. Their work covers next-generation energy conversion and storage devices such as heterojunction solar cells, solar-to-hydrogen converters and nanoscale semiconductor devices, as well as internet-inspired real-time grid monitoring and control algorithms. The technology developed in our energy innovation ecosystem is showcased through demonstrators and pilot projects. Another element of our strategy involves conducting real-world socio-economic experiments in order to identify possible catalysts of the energy transition.





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8. RESEARCH INFRASTRUCTURES

8.1. CATALYSIS PROCESS DISCOVERY HUB

Switzerland is a world leader in the transformation of petrochemical-based building blocks into high-added-value specialty chemicals. Currently, more than 90% of all synthetic compounds (such as agrochemicals and pharmaceuticals) are produced using catalytic processes driven mainly by fossil fuels. Discovering new catalytic processes and new compounds will be key to keeping Switzerland's chemical industry competitive and building a sustainable economy. If we want to create

a sustainable carbon cycle, free Switzerland from its dependence on fossil fuels and ultimately make the country carbon neutral, then we will need to develop selective conversion processes that generate lower waste, use less energy and emit fewer greenhouse gases. The key will be using catalysis to reinvent existing processes for producing specialty chemicals by shifting those processes away from petrochemical feedstocks and towards renewable raw materials.

To help achieve this goal, we will create a world-leading research center called Catalysis Process Discovery Hub (Cat+) that will be based jointly at ETH Zurich and EPFL. Cat+ will leverage the two universities' combined excellence in chemistry and chemical engineering to give Swiss businesses and researchers open access to state-of-the-art skills and equipment for catalyst discovery, reaction discovery and process optimization. The site at ETH Zurich will focus on heterogeneous catalysts, while the one at EPFL will study molecular catalysts. The center as a whole will provide the scientific community with advanced facilities for the discovery, characterization and large-scale testing of new homogeneous and heterogeneous catalysts and novel catalytic processes.

The center will use a high-throughput, machine-guided approach for the rapid discovery and evaluation of leads and parameter space. This will entail setting up an integrated workflow with fully automated processes for the synthesis, characterization and evaluation of molecular and solid catalysts, drawing on methods in computational learning,

machine learning and artificial intelligence. The goal will be to provide best-in-class facilities and expertise in:

- evaluating and screening new, highly efficient catalysts, processes and methods for converting feedstocks that are abundant today into high-added-value compounds
- using artificial intelligence, machine learning and high-throughput experimental methods to accelerate catalyst discovery and make other unexpected discoveries
- using spectroscopy instruments with unprecedented resolution and computing power to design new and better catalysts that overcome current obstacles like instability and deactivation
- supplying leading-edge know-how in the development of new, sustainable and efficient catalytic processes for the synthesis of highly complex compounds and smart materials.

8.2. BLUE BRAIN PROJECT

The Blue Brain Project (BBP) aims to build biologically faithful, digital reconstructions of the rodent brain and ultimately the human brain. BBP scientists run simulations to better understand the chain of events responsible for the brain's behaviors at different organizational levels up to and including cognition. Under the 2017-2020 strategy, the BBP focused on developing tools and methods for reconstructing and simulating individual and multiple interconnected brain regions, all the way to the thalamo-neocortical system of the mouse. The first BBP translational spin-off was created during this period and its

discoveries were disseminated to the wider scientific community. An independent review conducted by renowned scientists in 2018 commended the BBP's unique research capabilities and advancements.

Under the 2021-2024 strategy, the BBP's main research goals will be to develop (i) the first cellular-level detailed reconstruction and simulation of an entire mouse brain; (ii) a neocortical microcircuit complete with blood vessels, glial cells and molecular interactions; and (iii) a second draft of the neocortical microcircuit of the human brain at the cellular level. These goals are

within reach for the first time thanks to general advancements in computing, new pioneering methods for reconstructing and simulating brain tissue and data that have been made available by global initiatives such as the Allen Institute for Brain Science. Specifically, BBP scientists will work to mathematically predict complex datasets for less-studied brain regions, scale up their processes and computational capabilities to model the entire mouse brain, and expand their international research partnerships to study the human neocortical microcircuit and coordinate some of the most informative experiments on human brain tissue.

As part of the BBP, we also plan to create the Swiss Brain Observatory, an integrated platform of software and processes to provide “neuroscience simulation as a service” for major brain-research initiatives such as the EU Human Brain Project and the US Brain Initiative. The Observatory will be supported by joint R&D programs between universities and businesses, including programs for joint modeling and simulation and for coordinated learning opportunities for researchers and students (such as through MOOCs and summer

schools). The Observatory will also conduct outreach activities for the general public. By providing the capacity to integrate diverse data sources across several scales, the Observatory will be a strategic resource for the Swiss neuroscientific, pharmaceutical and medtech industries. One near-term goal will be to launch a spin-off for developing virtual prototyping systems for neurotech devices.

To fully exploit synergies between BBP and the other EPFL neuro partners and to provide a national service in computational neurosimulation, we will integrate BBP into EPFL under the 2021–2024 strategy, so as to i) continue the construction of an integrated value chain from theoretical neuroscience to neurobiology, neuroengineering, clinical translation and tech transfer, and to 2) provide and maintain a platform - ideally together with CSCS and SDSC - of outstanding and transformative simulation of the brain. Our goal for BBP is that, at the conclusion of its scientific journey, it will not only have delivered to its full ability on its ambitious goals, but also have nurtured further and longer-lasting impact through a cohesive community.

8.3. SWISS PLASMA CENTER

The Swiss Plasma Center’s main goals under the 2021–2024 strategy will be to contribute to the success of the ITER program, establish the physics and technology behind the DEMOnstration power station and demonstrate the feasibility of using fusion energy for peaceful purposes and for supplying the power grid. These goals are in line with the European Research Roadmap to the Realisation of Fusion Energy, which is being implemented by Euratom through the EUROfusion consortium (to which EPFL belongs). Assuming that Switzerland

remains a Euratom member under the next European Framework Programme, then EPFL – and more specifically, our Swiss Plasma Center – will play a key role in EUROfusion, in particular through the variable configuration tokamak (TCV), which is one of the few specific facilities necessary for the implementation of the Roadmap.

In previous years, we conducted general improvements to the Swiss Plasma Center’s facilities, including targeted upgrades to the TCV (which were funded by

EUROfusion and an ETH Board grant) and adaptations to the associated equipment to support the increasing fusion power of TCV plasmas. Now that those improvements have been completed, in 2021–2024 we will fully exploit the enhanced capabilities of both the TCV and smaller-scale plasma devices to address key areas of the Roadmap.

Engineers at the Swiss Plasma Center will combine plasma theory with computer simulations and experiments on both the TCV and basic plasma devices. They will focus on issues where a lack of understanding of the fundamental mechanisms at work is hampering our ability to model, operate and improve reactors. The experimental findings will be used to outline strategic priorities for further research through projects necessitating use of the TCV.

Finally, the Swiss Plasma Center will work to promote plasma technology transfer, spin-offs and cross-disciplinary R&D. We will study the environmental and societal applications of plasma technology – such as plasma-aided agriculture, sterilization and plasma medicine – in association with local businesses and life-science researchers. We will also use low-temperature plasma devices to optimize plasma sources, such as for advanced particle accelerators.



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9. SCHOOLS AND COLLEGES

9.1. ENAC - SCHOOL OF ARCHITECTURE, CIVIL AND ENVIRONMENTAL ENGINEERING

MISSION

ENAC is EPFL's school focuses specifically on sustainability in the natural and built environments, with activities spanning all three of EPFL's missions: research, education and innovation. As a school of architecture, civil engineering and environmental engineering, ENAC leverages EPFL's status as a cutting-edge

engineering school to develop scientific responses to today's environmental and societal challenges. We aim to design innovative, sustainable processes and methods and equip engineers with the knowledge, skills and tools they will need to spearhead future developments.

MAJOR CHALLENGES

Rapid changes to our planet's environment – driven by urban population growth, resource scarcity and climate change – are giving rise to an array of challenges whose ramifications will become increasingly evident in the upcoming decades. To address the threats caused by the climate crisis, urbanization and our increasingly fragile ecosystems, universities need to give architects, civil engineers and environmental engineers insight into the role they can play in transforming disciplines and developing cross-cutting, inclusive visions and solutions, operating as catalysts for the “socio-ecological transition” that must happen to sustain life on earth.

ENAC is well-positioned to address these challenges. Through our solid technological background, we showcase how technology can serve as a mediator between humanity and the built and natural environments. Importantly, this gives our students and faculty myriad opportunities to explore the scientific, cultural and human aspects of our relationship with these environments.

STRATEGIC RESEARCH AREAS

A. Climate-change anticipation, mitigation and adaptation

- Spearheading EPFL's climate research: In association with the Faculty of Geosciences and Environment at the University of Lausanne (UNIL), we have started to set up a joint EPFL-UNIL research center for action on climate change, called CLIMACT. The goal is to promote knowledge sharing and innovation for the evidence-based transformation of the ways in which our society functions and consumes resources in today's rapidly changing world. ENAC will contribute to leading the center jointly with UNIL, embarking colleagues from the other faculties and colleges, thus, drawing on EPFL's broad skills in climate change and technology and pooling them with UNIL's complementary expertise.
- Providing a testbed for research and development: We will develop a testbed for systems designed to model, mitigate and counter the causes and impacts of climate change. The testbed will allow engineers to transition from the simulation to the proof-of-concept stage of their projects through iterative feedback loops. The testing facilities will include mountain environments and urban areas and will provide a living laboratory covering a wide range of environmental conditions. The findings will help engineers evaluate tradeoffs among the critical factors of air, water, energy, food and health.
- Modeling and adapting to climate change: We will leverage our testing, technological and modeling capabilities to assess and predict changes to the natural environment across a range of climate and geographical conditions. We will step up our work in developing adaptation strategies for climate change through cross-disciplinary programs that cut across EPFL's schools and educational levels.
- Developing climate change mitigation technology: Negative Emission Technology (NET) is technology that directly removes and sequesters CO₂ from the atmosphere. ENAC in collaboration with other faculties at EPFL will explore potential applications for NET in the areas of carbon mineralization, enhanced weathering and next-generation membranes (e.g., new materials for separating CO₂ from air).

B. Digitalization of infrastructure and cities

- Enhancing our computational and integrative data-driven capabilities: Professionals in all three ENAC fields – architecture, civil engineering and environmental engineering – are facing an almost insatiable need for big-data analysis capabilities. The challenge they face is turning reams of data into actionable knowledge. We plan to shore up our strengths in data science by hiring faculty with backgrounds in specific fields as well as data science, and by conducting cross-disciplinary research with other EPFL schools.
- Developing sensing and actuation technology for the optimized design and use of infrastructure: We will make next-generation sensor technology available at several different spatial and time scales, enabling engineers to better design and build large sensor networks that can generate data at exponential growth rates. We will also increase our ability to design, develop and deploy multimodal sensor and actuation systems at different scales, so that they can be used to automate and improve existing methods for infrastructure design and use.
- Adding simulation layers to digital twins for infrastructure design, operation and maintenance: To help engineers factor uncertainty and risk analyses into their decision-support models, we will assess and explore the utility of analytical tools such as artificial intelligence, optimization, data analysis and mathematical modeling.
- Designing with resource constraints and radically rethinking existing construction methods: In the built environment, constraints on resources require a radical rethinking

of construction methods and the associated skills. We will contribute to these efforts by (i) assessing and minimizing the ecological impact of the built environment in terms of CO₂-footprint and global environmental cost, (ii) developing new concepts for the use of recycled components through advances in digital design and digital fabrication, and (iii) employing new materials with improved environmental footprints and life cycles.

C. Sustainable urban development

- Strengthening our expertise in sustainable urban development: We will build new laboratories to study emerging horizons in the field of sustainable urban development, with a focus on modern concepts such as the carbon-neutral circular economy, sustainable urban metabolism, life-cycle and risk analyses, shared and on-demand transportation systems, and distributed energy systems and networks.
- Supporting integrative, systemic urban development: Using a systems-of-systems approach, we will develop new, human-centric transportation and housing paradigms for highly populated urban areas and their suburbs. This systems-driven approach will help engineers manage small- and large-scale parallel networked systems using a combination of flexibility, cooperation and collaboration.
- Linking technology at different scales through network analysis and modeling: Sustainable urban development requires efficiently bringing together and acting on knowledge collected across different scales and fields. We will therefore develop and promote multiscale, multimodal views of urban systems and

the corresponding structures and flow mechanisms (e.g., flows of microbes, energy and humans), including for large networks with numerous interconnected infrastructure systems and subsystems.

- Transforming regions by reshaping the links between urban and rural areas: The boundaries between urban and rural areas are blurring, requiring policymakers to reconsider existing methods for producing food and ensuring public health. We will help policymakers navigate these changes by developing new approaches and strategies for implementing targeted, well-informed and proactive measures. This will entail modeling and analyzing the effects of land-use changes on factors such as urban heat, urban ecology and urban agriculture.

D. Technology for basic utilities

- Leveraging synergies in technology development: EPFL has extensive technology-related expertise in areas such as image and signal processing, control systems, robotics, machine learning, data analysis, energy systems and large-scale computing under uncertainty. At ENAC, we will explore new research avenues and promote translational research in a variety of applications by partnering with other EPFL schools in research projects and cross-school professorships.
- Driving the shift towards energy self-sufficiency and carbon-neutrality: We will continue to lead efforts in the development and evaluation of distributed energy systems (using hydro, wind, geothermal and solar power), as well as energy-efficient systems for the construction and operation of infrastructure. We will also support the societal transformations that are needed to shift to a balanced urban metabolism and a circular, zero-carbon society. Through our involvement in EPFL's Energy Center, we will play an active role in achieving EPFL's energy and sustainability goals.
- Developing improved systems for sustainable water management: Many water treatment plants in Switzerland must be upgraded by 2040, requiring a total investment of some CHF 1 billion. We are working with Eawag to update our degree programs (e.g., such as by hiring joint ENAC-Eawag professors) with the ultimate goal of helping water treatment plants maximize their return on investment. We will give engineers advanced training in water management systems, so that they can develop new water treatment technology and processes. Our efforts will focus in particular on the utility and innovation potential of emerging fields such as sensors, big data and AI.
- Anticipating new transportation technology: Technological advances in fields such as autonomous vehicles, electrification and shared vehicle platforms are profoundly changing the structure of transportation services. City officials would like to make their transportation systems more predictable and controllable through the better use of existing capacity and resources. We are supporting these efforts by developing, modeling and assessing new modes of transportation and how they can be incorporated into existing systems.

EDUCATION

We will review our existing degree programs to make sure they are fully aligned with future technological and societal needs. Our goal is to train engineers and architects who excel in their fields and are capable of working effectively with professionals from other fields to address sustainability challenges. This capacity for cross-disciplinary collaboration will be essential for ongoing innovation. Under the 2012–2024 strategy, our efforts to update our degree programs will focus on:

- **New minors:** We will look into creating minors in three of our strategic research areas: climate change anticipation, mitigation, and adaptation; digitalization of infrastructure and cities; and sustainable urban development. The minors will be housed within individual ENAC sections and touch on all three ENAC disciplines (and potentially other fields as well). We plan to partner with UNIL for the climate minor and with other EPFL schools for classes in digitalization and artificial intelligence.
- **The Design Together program:** we will enhance the curriculum for this program by providing additional opportunities for students from the three ENAC disciplines to work together in classes taught by professors from several different fields (at both the Bachelor's and Master's level).

INNOVATION

ENAC's areas of research are intrinsically relevant to today's key societal challenges. Our pioneering research gives rise to innovative solutions for addressing societal, environmental and technological issues, helping to further progress on sustainable development and climate-change mitigation. We will expand our support for innovation and technology transfer by giving researchers easier access to the resources provided by the Vice Presidency for Innovation, and by fostering an entrepreneurial spirit across our community.

By grouping our research projects into the four strategic areas mentioned above, we will provide clear entry points for businesses and public-sector organizations. This will help create a beneficial feedback loop between the academic and business worlds for technology transfer and private-sector funding. Innovation is a pillar of our school and an essential component of our research.



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9.2. IC - SCHOOL OF COMPUTER AND COMMUNICATION SCIENCES

MISSION

IC is a world-leading center for education, research and innovation in the computer and communication sciences. We teach the fundamentals and details of an exciting, disruptive field, perform research that pushes the boundaries of knowledge, develop commercial applications for our technology and encourage entrepreneurship by our faculty and students.

RESEARCH

Computer science is a rapidly evolving field that has revolutionized many aspects of our daily lives. Apple's iPhone came out just 12 years ago, WhatsApp just ten years ago, and deep neural networks just seven years ago. Data science has also developed exponentially during this time. These technological advances – which build on many years of computer science research – are milestones along a path, not the end of a journey. Many challenging theoretical and practical problems remain unsolved. We still do not know, for example, how to write foolproof software, build trustworthy systems, learn from examples reliably or optimize many other fundamental mechanisms. At the same time, exciting new research fields and applications are emerging. Computer scientists in general, and those at IC specifically, are having to balance the competing demands of solving known problems and directing their efforts towards making new discoveries.

We already have a good idea of what the next step will be in the technology-driven revolution: building increasingly sophisticated systems that draw on artificial intelligence, data science and machine learning. These systems will bridge the physical and cyber worlds in

new and diverse ways and be capable of actions previously considered to be exclusively human. They will be not just robots, but smart robots and virtual agents capable of learning new assignments while autonomously and continually adapting and improving; not just automated manufacturing systems, but machines that can continuously monitor, adapt and learn while improving complicated manufacturing processes for materials and pharmaceuticals; not just self-driving cars, but regional transport systems that autonomously move people and goods seamlessly through Switzerland; not just the web, but “time machines” that integrate and animate historical information.

None of these can be built with the current state of the art, and all require advances in computer science. EPFL has considerable expertise in many of these areas. At IC, we will work with other EPFL schools to provide technological leadership in the theory and practice of several fields, including machine learning, computer vision, audio-visual processing, speech, natural language processing, artificial intelligence, cyberphysical systems, human-AI collaboration, agents, planning, complex systems, programming models and tools, software verification, security, trustworthiness and privacy.

At the same time, the foundations of computer science are shifting. The most evident change is that the 50-year reign of Moore's law is coming to end, with the rate of increase in processing power slowing over the past few years – at least for silicon-based circuits. However, technology using new materials, quantum physics and biological mechanisms is being developed to solve problems that cannot be solved with existing silicon-based systems and architecture. For instance, quantum computing – which

employs a radically different computational model – may yield solutions for important but currently unsolvable problems in optimization, materials design and other areas, while simultaneously driving fundamental changes in cryptography. At the other end of the spectrum, biologically-inspired technology shows promise for the design of energy-efficient, robust and failure-tolerant devices, and has the advantage of being able to draw on many different biological mechanisms (such as those used by neurons) as computational models.

Advances in computer science should also be applied to correct some of the societal problems caused by its past failings, such as the abysmal security of computing systems, pervasive software defects (bugs), disregard for privacy and personal identity, impaired trust in societal institutions and the educational challenges of digitalization and computational thinking. Effective solutions to these problems will benefit society as a whole and will provide a more stable foundation for further discoveries in the field of computing. Intelligent systems, for instance, will face many societal barriers to adoption amid well-founded concerns about their trustworthiness.

At IC, we are adapting our research to meet these challenges. Our collective focus has expanded beyond the core areas of computer and communications science, and we have formed partnerships with scientists in other fields, colleagues at ETH Zurich and governments and NGOs. In the past five years, we have hired 13 faculty members (including two joint members) and opened four R&D centers: the Swiss Data Science Center (SDSC), the Scala Center, the Center for Digital Trust (C4DT) and LEARN. We have just opened a fifth, the Center for Intelligent Systems.

But this is not enough: we need to expand our school as a whole. At the end of 2018,

we had 44 faculty members but only 39.75 FTEs (since two professors also serve as full-time EPFL administrators). While this is two FTEs more than we had in 2013, the number of entering undergraduate students rose by 51% over that same period, and the total number students rose by 20%. Top computer science departments in the US grew far more rapidly as a result of higher enrollment, and most are now 50% larger than IC. At the same time, computer science as a field is expanding to include a variety of connected research areas. Most salient of these are data science and machine learning, which are emerging as fundamental methods applicable to most areas of research and to many industries. It is hard for a school like IC to hire faculty in these new areas because of competition from other universities and industry. However, we must step up our efforts to do so – not just in machine learning and data science, but also in closely linked fields such as computer vision, natural language processing, speech and robot planning.

Some of our faculty positions will be renewed through retirement. Eight professors will reach retirement age between 2021 and 2024, or around 20% of our total faculty. While we will certainly feel the loss of these colleagues, it also means that we will be able to redirect some of our resources to other disciplines, for the benefit of both IC and EPFL. But redirecting even half of those resources will not be enough to build a strong, diversified research group (3–4 professors) in more than one fundamental area. Moreover, renewing our faculty addresses only the shift in research areas, it does not resolve the issue of increased student enrollment.

Another goal at IC will be to initiate larger, more ambitious research programs. Our research is currently performed mainly through small projects, typically funded and staffed by a single laboratory. This is a proven approach to research and is in line

with many faculty members' preferences. However, large projects involving researchers from several fields can address more important, challenging and visible problems – and consequently attract more funding and increase our school's visibility and impact. IC projects that have played this role in the past include NCCR Mobile Information and Communication Systems and Nano-Tera. Going forward, we need to cultivate more ambitious projects at IC, at scales all the way up to that of NCCR. This will allow us to conduct more joint research with other fields and increase our visibility. One important vehicle for cross-disciplinary R&D is the new Center for Intelligent Systems, but we also need to take the lead in initiating programs in other areas of importance to computer science.

EDUCATION

Computer science is attracting a growing number of undergraduate and Master's students. Undergraduate enrollment has more than doubled in the past decade. When our school was created, we had 25 students (all levels) per FTE faculty member. That number is now 42 – the highest at EPFL. We teach many of the largest courses on campus as well. While we have not significantly increased our faculty over that period, we have introduced two new Master's programs (in data science and cybersecurity) that address important technological and societal issues and offer excellent job prospects for students.

Another challenge we face, in addition to serving a growing number of students with limited resources, is the need to forge ties with other disciplines. Conceptual methods and discoveries originating in computer science, especially the method of computational thinking, are increasingly being adopted by other fields. We started offering an introduction to computational thinking class for all EPFL students over six

years ago, and this class has been highly popular. The next step will be to extend this approach to equip students with robust skills in not just data science, but the life sciences as well (for example), so that they acquire the field-specific knowledge and analytical techniques necessary to solve complex problems in industry.

We are in the process of reviewing certain aspects of our curriculum. For example, our undergraduates currently take up to eight classes per semester after their first year. By contrast, their counterparts in the US take fewer classes, but each class covers the material in more detail. We are also reviewing the way we divide up our undergraduate sections – into computer science and communication systems – since communication systems is not a field that high-school students are familiar with. In our school, communication systems cover the more theoretical and mathematical subjects of computer science, with a 75% overlap in course requirements. Making this distinction more explicit might simplify matters for students.

Another priority is to create identifiable minors for Master's students so that they can follow tailored study programs with clear endpoints. The alternative – creating new Master's degrees in data science and cybersecurity, for example – would be administratively time-consuming and problematic, especially in such a rapidly changing field. In addition, students need guidance in putting together coherent study programs. We are therefore considering the minors as a way to adapt our Master's programs and encourage specialization.

Emerging fields such as intelligent systems and education technology would also benefit from distinct programs at both the undergraduate and PhD level. We recently opened the Center for Intelligent Systems through a joint effort with other EPFL schools; this Center will probably

evolve into a research institute with its own Master's and PhD programs. We also have other important initiatives under way, such as in education technology, to attract the resources we need to create satellite programs.

IC is also heavily involved in educational outreach programs for primary and secondary schools. The programs are designed to help these schools develop intellectually stimulating computer science classes for young students. The goal is to give students more insight into the field and help address the challenges of digitalization in Switzerland. We are in talks with local education officials about using our materials to train teachers and develop guidelines for primary and secondary schools so that they can create age-appropriate computer science classes. At EPFL, we offer a computer science class to first-year students that provides an intriguing yet rigorous look at the underlying concepts.

INNOVATION

Our school engages closely with the global technology industry through an array of joint research programs with major multinationals including Google, Microsoft, IBM and Intel. Swiss companies

are generally consumers of technology more than producers, and many of our joint ventures with local companies are either spin-offs or agreements to develop and market technology resulting from IC research.

Our R&D centers - EcoCloud and the more recent SDSC, Scala, and C4DT - take a proactive role in collaborating with both Swiss and international companies. EcoCloud has broad industry support and has transferred technology to many IT and data-hosting companies. C4DT shares its digital trust platform with more than a dozen firms, developing new products that use blockchain and data-security technology developed by our engineers. Scala supports the continued development of the popular Scala programming language, which was created at IC, in association with the multinationals that use it. And our EdTech Collider currently hosts 76 startups in the field of educational technology.

We believe that our school's new research orientations will give rise to innovative local businesses that will market the technology developed at our labs. These businesses will provide further opportunities for joint research and benefit Switzerland as a whole.

9.3. FSB - SCHOOL OF BASIC SCIENCES

MISSION

FSB conducts cutting-edge research and provides world-class educational programs in chemistry, chemical engineering, mathematics and physics. We give students a strong foundation in these fundamental sciences and prepare them for fulfilling careers in business and academia. The research performed at our school is both collaborative and cross-disciplinary, and pushes the boundaries of existing knowledge.

RESEARCH

There is no leading university worldwide without substantial strength in the fundamental sciences. These sciences are characterized by curiosity-driven research that is fueled by scientists' imagination and creativity. At the same time, much groundbreaking research in the fundamental sciences is inspired by a desire to develop important applications, to better understand the world around us and to find answers to the challenges of modern society.

Research in the fundamental sciences often shows its value on a much longer time scale than for the applied sciences and engineering. Therefore, to advance the fundamental sciences at EPFL, we should focus not on current topics or trends, but rather on areas of strength and initiatives that attract the most creative, innovative students and researchers. This includes offering conditions and opportunities that allow them to pursue long-term research efforts in a strong collaborative and interdisciplinary spirit.

This focus on excellence permeates FSB, which is consistently ranked as the best school at EPFL. However, maintaining

this position and further expanding our capabilities will require growing our school in different ways. Compared with most other similar schools around the world, the three institutes at FSB – Chemical Sciences and Engineering (ISIC), Mathematics (MATH) and Physics (IPHYS) – are small and have experienced only limited growth during this decade of substantial expansion at EPFL as a whole. That is beginning to affect our research and education and should be addressed through targeted growth initiatives in priority areas. One opportunity to refocus our scientific efforts will come with the retirement of more than 20 professors during the next five years. However, this will not address the more basic issue of how to better serve the rapidly growing student population at EPFL and how we can spearhead more large-scale, collaborative flagship projects.

Breakthroughs in the fundamental sciences often occur at the crossroads of two or more traditional fields or by combining traditionally disparate methods within the same fields. Therefore, we must prioritize the hiring of individuals who adhere to such a collaborative, dynamic approach, and we should facilitate their efforts by creating an environment that provides the right intellectual support and research facilities. Our most pressing societal problems cannot be solved within a single school or research institute, but rather require broad cross-disciplinary collaboration – and this is where FSB can play an important role.

In addition to the EPFL-wide research centers that we already participate in, such as the Center for Intelligent Systems, we also play a leading role in large national and international projects like NCCR and several EU Flagship programs. Historically, both ISIC and IPHYS have been involved in such efforts, but there is scope for greater involvement, especially by MATH.

Chemistry

There is a revolution underway in the field of chemistry as science and technology move to the atomic scale across applications – from pharmaceuticals and computing to precision manufacturing. This paradigm shift is fueling demand for new types of compounds and materials. At the same time, chemists are applying some of the advanced methods being developed in computer science to chemical processes, resulting in completely new approaches to understanding complex systems. This has spurred the rapid development of physical methods for atomic-level analyses, as well as the use of computer modeling as an accurate, efficient method for discovering new functional compounds and materials. These tools are enabling scientists to develop innovative solutions to challenges in natural and synthetic chemistry. Technological advances in high-level instrumentation, large-scale facilities and high-performance computing – which have traditionally been oriented towards physics and structural biology – are now also transforming chemistry, with the advent of high-resolution electron microscopy, ultra-high field NMR spectroscopy, second-generation synchrotrons, and X-Ray free electron lasers.

Applications in renewable energy and storage, sustainable chemical production and next-generation therapeutics are seeing major societal demand for new chemical compounds. Chemists are working to address these challenges, especially in emerging fields like atomic-level precision engineering, atomic-level materials science and new chemical functionalities. Recent developments in computing power, characterization, nanoscience and synthetic biology have enhanced chemists' ability to observe, predict and control molecular-level structures in complex architectures. Ongoing advances in computing speed and machine learning will further transform the fields of chemistry and chemical process development.

Under the 2021–2024 strategy, we will aim to establish an EPFL-wide research center on metal halide perovskites to build on EPFL's unique standing and recent achievements.

Mathematics

The field of mathematics has always been driven by both internal dynamics and developments in the fields where it is applied. However, the previous tendency towards fragmentation in this field is being replaced by a trend towards convergence. Pure and applied mathematics are converging to an increasing extent and interfacing with new research areas. As a result, when hiring new professors, our school should focus on broad excellence (as opposed to narrowly defined skill sets) and seek candidates who can forge ties both within and outside mathematics.

Although MATH is smaller than most universities' mathematics departments, it has a solid reputation internationally and is well known in a number of areas, such as computational mathematics, algebra, algebraic/arithmetic aspects of geometry, and probability. In addition, recent hires into our faculty have bolstered our capabilities in data science. However, MATH still has minor weaknesses, primarily in three areas: analysis and analytical aspects of geometry, discrete mathematics and statistics. These areas will be a priority for hiring under the new strategy.

MATH scientists are poised to establish meaningful contacts in applications such as quantum computing, big data, machine learning, imaging, complex systems, materials, physics and neuroscience. They are also in talks to create joint positions to strengthen ties across EPFL.

We are working on plans to revamp our statistics department with additional research and education partnerships across EPFL as well as a new statistical

consulting platform for engineers involved in statistical design, experimentation and analysis. At the same time, we will increase the Bernoulli Center's visibility within EPFL. The center is of notable strategic interest for EPFL, as it is on par with its counterparts at top mathematics departments elsewhere. We intend to broaden the center's scope and capacity to include theoretical physics and computer science.

Physics

Our physics department is at a turning point since many professors will be retiring in a short timeframe. This will give us an opportunity to build up our strengths and explore new, promising research directions in association with EPFL professors outside IPHYS and FSB.

The field of quantum science and technology is growing rapidly with discoveries that will affect society in the near future. And although we have several outstanding faculty members in this field, EPFL is not yet an established leader. Therefore our top priority at IPHYS is to increase our skills in this area, especially in quantum sensing, to parallel the research being done at ETH Zurich on quantum computing and in Geneva on quantum communications and cryptography.

A further goal is to develop strong biophysics research capabilities at IPHYS, separate from those at the School of Life Sciences, that will study the fundamental laws governing the behavior of living systems at different levels. This aligns well with the Imaging@EPFL and Health Sciences and Technology strategic research areas.

Another area where IPHYS is particularly strong is condensed matter physics. In the past, this type of physics has been used to develop semiconductor heterostructures and quantum photonics, but today the focus is shifting towards new low-dimensional materials, nano applications and magnetic

systems. We will issue a call for proposals in ultrafast X-ray technology for a project involving SwissFEL (at the Paul Scherrer Institute).

As a founding member of the LHCb project group at CERN, EPFL is playing an important role in experimental high-energy physics. A second phase of the LHCb project will begin in 2021 with an upgraded testing program. To maintain our leadership role in this field, we will expand our capabilities in high-energy physics with a particular focus on muons and neutrons. In experimental astrophysics, EPFL currently plays a minor role since we have only one chair. However, we plan to announce a new position in this field given that ETH Zurich will probably scale back its research in experimental astrophysics as part of its restructuring. Depending on whom we select to fill the position, there may be an opportunity to build strong ties with image processing and mathematics.

Finally, our research efforts in nuclear fusion (at the Swiss Plasma Center) and fission (in association with the Paul Scherrer Institute) are recognized internationally and are of strategic importance in Switzerland. We intend to continue these efforts with the same number of researchers.

EDUCATION

The number of incoming students to FSB has grown by nearly 50% over the past ten years. These students are taught in their first year mainly by physics and mathematics professors. However, the number of professors in these fields has not grown in line with the student body; on the contrary, it has remained largely constant. This disparity is severely impacting our professors' ability to teach more advanced courses. For example, MATH cannot give teaching credits for PhD classes, which is affecting the quality of our doctoral school. In addition, the heavy teaching workload

for PhD students makes it difficult to attract the brightest candidates and is becoming an issue during hiring (such as for joint positions). Our doctoral school plans to introduce a pure fellowship program for first-year students, similar to what the School of Computer and Communication Sciences and most leading schools in the US already offer.

INFRASTRUCTURE

One of EPFL's core strengths is our cutting-edge research facilities, and this is especially true for the experimental sciences. However, FSB is located in the oldest building on campus, and this is starting to cause problems. For our School to maintain its scientific excellence, we need a new building designed to high research-oriented specifications (such as for temperature and vibration control). Not having more modern facilities will hamper our ability to grow and conduct advanced research and educational activities, and ultimately to reach our full potential.

9.4. STI - SCHOOL OF ENGINEERING

MISSION

STI's mission is well-aligned with the core values of the ETH Domain. It entails educating well-rounded students and preparing them for careers in business and academia, fueling new research discoveries in engineering, promoting technology transfer, adopting innovative approaches to engineering education, and developing engineering-based responses to key societal challenges.

We are carrying out this mission in a climate of rapid, even disruptive change in all engineering disciplines. As a result, we are continuously looking to enhance how we perform our research, educate our students, and interact with industry and society at large. Our ambition is to position STI among the top ten programs worldwide in engineering prominence.

Our strategy for achieving this goal is based on three objectives:

1. Given the size of our school, we plan to focus our efforts on excellence in key strategic areas. We cannot afford to spread our resources too thin and become a marginal contributor to engineering discoveries.
2. We should maintain our strengths in core engineering fields. This is because strong fundamentals are the real drivers of confidence, creativity and innovation.
3. Successful engineering schools are those that make major contributions to solving societal problems. STI should therefore continue to play a leading role in technology transfer, forge close ties with industry and contribute to advances in the life and social sciences, sustainability, security and automation.

STRATEGIC RESEARCH AREAS

Driven by the above considerations, and building on the strengths of the EPFL ecosystem, STI has identified six strategic research areas where we can make an impact in terms of research, education and innovation: (i) Engineering in the Life and Health Sciences; (ii) Engineering for a Sustainable and Secure Society; (iii) Engineering for a Data-Driven and Networked Society; (iv) Engineering of Complex and Intelligent Systems; (v) Innovation in Engineering Education; and (vi) Engineering Entrepreneurship, Ethics and Societal Impact. They all aim to address the transformational changes arising from the accelerated convergence of electronics and biology/medicine, the blending of the physical and virtual worlds, the emergence of data-driven and networked societies and a shift towards smart automated systems and renewable resources, energy and materials. Our strategic research areas are purposely stated in broad terms to pave the way for joint programs with other EPFL schools, as explained below, and with the broader ETH Domain..

Engineering and Life Sciences

The fields of engineering and life science are merging as researchers develop increasingly miniaturized and invasive devices for probing and interacting with living cells. These technological advancements will drive new scientific discoveries and treatment possibilities. As a result, there are ample opportunities for STI to conduct joint research with the School of Life Sciences. We are already working with that school to expand our two joint research centers: the Center for Neuroprosthetics and the Institute of Bioengineering. We are also coordinating our research efforts in neuro-engineering and neuro-technology.

Going forward, we need to step up our activities in key supporting areas such

as brain-machine interfaces, biomedical robotics, intelligent bio-instrumentation, engineered living systems and integrated biosensors and bioelectronics. The first two areas involve developing assistive technology so that patients can interact with their surroundings, such as by using personal rehabilitation devices. The third area looks at building autonomous robotic microscopes that combine physical methods, biological models and machine intelligence to maximize image quality. The fourth area harnesses living organisms' precision synthesis and manufacturing capabilities at different levels (molecular, cellular and tissue) to construct sophisticated, functional mini-tissues or mini-machines outside the body. Discoveries in this area could lead to new frontiers in medicine and manufacturing. All these research areas are highly interdisciplinary, drawing on skills from bioengineering, biology, chemistry, materials science, mechanical engineering, electrical engineering and computer science.

Engineering and Computer and Basic Sciences

The merging of the virtual and physical worlds is driving the development of wearable technology, smart devices, augmented reality and intelligent systems. Autonomous systems are a key enabler for these developments, which are expected to have profound implications on transportation, commerce, employment, healthcare and manufacturing. A new paradigm will emerge of interconnected, intelligent systems with a "mind" of their own. This will require new forms of engineering and therefore new approaches to engineering education, in order to design intelligent machines that can share the same physical space as humans. To that end, there are ample opportunities for STI to conduct joint research with the School of Computer and Communication Sciences and the School of Basic Sciences. For instance, we already teamed up with these schools

to create the Center for Intelligent Systems in 2019. This center looks into the foundations of intelligent systems as well as the associated software, hardware and ethical issues; it also studies cross-disciplinary applications in robotics, digital twin systems, bio-inspired intelligent systems and intelligent manufacturing.

Going forward, we need to step up our activities in key supporting areas like control and automation, secure hardware design, micro- and nano-sensors, autonomous embedded systems and micro-mechatronic systems. The first area addresses the fundamental technology involved in the design of autonomous and networked systems. The other areas are essential to support the growing importance of the Internet-of-Things (IoT) and intelligent sensor technology for tomorrow's autonomous systems. These trends are making it crucial for hardware devices to be embedded with advanced security features. By increasing our research efforts in these areas, STI will contribute directly to EPFL's digital trust initiative and to Swiss national priorities such as cybersecurity.

Engineering and Data and Network Sciences

The rapid growth in data and network sciences, along with advances in machine learning and computing power, are having a major impact on engineering design. This is leading to smart new design tools that exploit the design space more fully. These tools will help engineers discover new materials and processes, design more responsive systems, run advanced manufacturing systems, and perform more sophisticated climate and space analyses. As a result, there are ample opportunities for STI to conduct joint research with the School of Computer and Communication Sciences, the School of Basic Sciences, the Swiss Data Science Center, the Paul Scherrer Institute, EMPA,

and the IDIAP Research Institute. We created a new faculty position in data-driven engineering design in the 2018–2019 school year. Obtaining sufficient faculty expertise in this field is essential for preparing students for impactful careers in a data-driven society where issues like data interpretation, privacy and ethics will become paramount.

Going forward, we need to step up our activities in the analysis and design of complex and networked engineering systems, circuits and technology for large-scale data processing and for data-enabled materials discovery and synthesis. The first two areas will support the expected rapid development of networked dynamic systems (such as networked robotic systems) and sensor-based data collection systems. The third area looks at data-driven approaches to the design, discovery and synthesis of new materials and at the creation of an “internet of materials” that can lead to more sustainable, efficient designs.

Engineering and Sustainability

The most imminent challenges currently facing humanity relate to the sustainable use of energy and materials, mitigating climate change and greenhouse gas emissions, reducing waste and pollution, and managing population growth and urban development. This will require redesigning our entire socioeconomic system, which is made up of independent yet highly integrated circular flows of energy, materials, natural resources, products, waste and people. What's more, these flows are often linked with digital data flows.

Developing solutions to the aforementioned challenges will require breakthroughs in data science, data-enabled engineering, robotics, machine vision, intelligent and autonomous systems, advanced manufacturing and telecommunications

systems. Engineers can start by promoting sustainable product design through the use of data analytics to conduct product life-cycle assessments in the early stages of development. Materials science can also provide technological solutions through the development of recyclable, bio-sourced, and bio-degradable plastics, sustainable construction materials (which are otherwise a major source of CO₂ emissions), materials for benign and sustainable energy storage, photovoltaic materials, gas separation membranes for fuel cell and carbon capture technology, and advanced materials for more fuel-efficient transportation systems.

Going forward, we need to step up our activities in energy storage, energy science and technology, structural and engineering materials, data-enabled materials discovery and synthesis, and sustainable and circular manufacturing. The first area reflects the growing use of new wireless and autonomous devices to manage energy storage systems. The second and third areas involve designing sustainable materials and processes as well as adaptive and autonomous materials. The fourth and fifth areas relate to manufacturing cycles and sustainability.

Engineering Education for the Future

Engineering programs must adapt to the transformations under way in their fields in order to prepare students for successful careers and for the environmental, ethical and privacy issues that will come into play as the world becomes increasingly interconnected. While engineering programs should always provide a strong background in the fundamentals, they will need to be enhanced with classes in computational thinking, complex systems, data and network science, energy, design and the arts. At STI, we intend to raise students' awareness of the ethical issues related to new technology and the corresponding societal implications. This

will be done, for example, through the team-oriented design course we give jointly with the College of Management of Technology. Our students' educational experience will be supplemented with interactive online tools and virtual experimentation and immersion, requiring new skills-assessment mechanisms. In parallel, we will give students hands-on training through basic lab classes and projects as well as projects carried out in cross-disciplinary teams at the new prototyping and "maker" spaces at the Discovery Learning Laboratories. We will invest in attracting talented students at all levels and have recently introduced a summer internship program for Master's students to bring highly motivated students to our campus. We also plan to consolidate the number of courses and PhD programs we offer to make them more coherent and attractive.

Engineering Innovation

STI is a powerhouse of innovation at EPFL, accounting for close to 50% of all patents submitted by EPFL and close to 50% of all EPFL spin-offs. Our joint ventures with Swiss and international companies continue to thrive, and the size of direct and indirect funding from joint R&D projects has been rising steadily. Despite these positive developments, we still see room for expanding our technology transfer and joint research efforts, given the vibrant innovation ecosystem at EPFL and the broader Lake Geneva region. To that end, we recently created the new position of Associate Dean for Industry and Innovation and will begin systematically identifying unique technology developed at our labs that could either be of interest to an existing business or lead to the creation of a startup.

We plan to set up mentoring programs with our partner businesses and alumni. Our alumni in particular constitute an important, but largely unexplored resource for our

school. We will work with the EPFL Alumni Center to better engage with our alumni, hold events to showcase our school's developments, and encourage alumni to become involved in networking, fund

raising and mentoring activities. We will also hold workshops and special events to promote entrepreneurship among our students.

9.5. SV - SCHOOL OF LIFE SCIENCES

MISSION

Research at SV aims to understand the fundamental mechanisms of living organisms and use this knowledge to improve healthcare and medicine and serve society in an ethical manner. Research, education and innovation at our school take place at the crossroads of biology, medicine, physics, chemistry, engineering, computer science and environmental science. We therefore serve as a center of excellence for healthcare and life science at EPFL. In addition, our scientists use quantitative, computational and engineering methods to generate, interpret and use the vast amounts of biological data they collect.

ongoing, blue-sky research on the basic mechanisms of life.

While our school has traditionally focused on mammalian biology and diseases, we plan to expand our research scope to include synthetic biology on single-cell organisms such as bacteria, yeast and algae. This field is highly interesting from an educational perspective, especially for a school that trains engineers in life science. Furthermore, this research could help address major societal issues such as water decontamination and energy production. Finally, research in synthetic biology would bring together scientists from all EPFL schools, especially in the disciplines of chemistry, environmental science, engineering and computer science.

CHALLENGES

One of the biggest challenges our school currently faces is building up expertise in three key areas: the analysis and integration of large biological data sets; the development of predictive models of biological systems; and computational biology in general.

In terms of addressing societal challenges, we will further our efforts on the following fronts: understanding brain function and dysfunction linked to diseases and aging; understanding the basic mechanisms of cancer and metastasis; and understanding the importance of metabolism and inflammation in these complex diseases. Research in these areas will build on our

STRATEGIC RESEARCH AREAS

Neuroscience and neurotechnology

This is a joint research area with the School of Engineering and involves synergies with the Blue Brain Project. One of our key goals here is to develop a common framework spanning neuroscience, neurocomputation, neuroengineering and neurotechnology. Research in this strategic area focuses on the following three applications:

1. Motor function and dysfunction: This is already an important research topic at EPFL and should be expanded to include the cerebellum, midbrain and brainstem

and oriented towards diseases such as Parkinson's, Huntington's, spinal muscular atrophy, amyotrophic lateral sclerosis and other motor neuron diseases.

2. Cellular and molecular neuroscience: While this is likewise already an important research topic at our school, it will be expanded to include dendritic integration, synaptic plasticity, neuromodulation and the development of new genetic animal models of brain disorders (including motor disorders).
3. New neuroscience technology: We are working to develop new technology that allows scientists to observe brain function in greater detail. This technology could include advanced methods for *in vivo* imaging, genetically-encoded optical sensors and controllers for neuronal functions, and advanced computational methods that use machine learning to analyze experimental data.

Cancer

EPFL holds a leading position in cancer research among Swiss universities. It is home to the ISREC Institute, which has a long tradition of cancer research, and the Institute of Bioengineering, which also has cutting-edge capabilities in this area. EPFL played an instrumental role in setting up the Swiss Cancer Center Leman (SCCL), alongside CHUV-UNIL and HUG-Unige, and is involved in the new Agora Translational Cancer Research Building on the CHUV campus. Agora will bring cancer scientists and engineers from EPFL together with physician-scientists at CHUV and enable them to use CHUV's clinical facilities. Under the 2021–2024 strategy, our cancer research efforts will focus on four objectives:

1. Deploying EPFL's cross-disciplinary skills and expertise to address cancer challenges: We aim to create an EPFL-wide research center in cancer

science and engineering, which would provide a forum for cross-disciplinary communication, collaboration and innovation in order to gain further insight into disease mechanisms. Its research would involve developing precision diagnostic technology and traceable, low-cost early-detection systems. We hope to ultimately design new protocols for improving the treatment of cancer patients, ideally by disrupting the adaptive resistance mechanisms that limit the length of the therapeutic benefits of most cancer drugs.

2. Anchoring the SCCL as a key player in cancer research: We intend to maintain EPFL's important role in the SCCL, contributing both leadership and cross-disciplinary research groups specialized in cancer and bioengineering. The SCCL has all the elements to be recognized internationally as an integrated cancer research center – the first ever in Switzerland – and EPFL's continued involvement will be crucial to achieving that goal. There are only a handful of laboratories in the Lake Geneva region that are devoted entirely to cancer research. EPFL therefore provides a strategic critical mass and makes a unique contribution through its quantitative, cross-disciplinary approach to science and engineering.
3. Expanding our cancer research faculty: Cancer research at our school can be successful only if we continue to hire world-class faculty, both at our main campus and at Agora. This issue has become particularly pressing following the recent departure of four cancer-research faculty members whose international reputation had been a key benefit to our school. While ISREC's size is what allowed EPFL to play a central role in founding the SCCL, its diminishing status portends a decline

in our impact at this exciting frontier of human medicine. No new faculty members have been hired into ISREC since 2014, and the institute is facing a shortage of tenure-track assistant professors. It is therefore essential that we hire more of these professors – the lifeblood of top universities – in fields at the forefront of cancer research, beyond the fields already represented at EPFL.

4. Introducing a minor in cancer research: This minor would teach not only the basics of cancer biology but also essential concepts in immunology, synthetic biology and bioengineering in order to prepare students for careers in universities, hospitals or the private sector.

Computational and Data-Intensive Life Sciences (CompBio)

Recent rapid advancements in data-processing technology are revolutionizing all scientific fields. But no field is projected to generate as much data as the life sciences, surpassing even astronomy. From entire genomes and quantitative images of cells, organs and organisms, to digital data on human diseases, behaviors and epidemic spreading, these new data bring entirely new challenges and opportunities for inspiring, impactful discoveries. They have the potential to yield the next breakthroughs in all areas of biology, including cancer, infectious diseases, neuroscience, cell development and regeneration, metabolism and medicine more broadly. To realize this potential, scientists must be able to share large-scale confidential medical data, and this implies developing effective trust protocols. Individuals, institutions and nations with the capacity to master these data challenges will undeniably have a competitive advantage.

Crucially, mastering these challenges will require a deep understanding of the

scientific problems at hand as well as the computational processes needed to solve those problems. Cross-disciplinary project teams will remain important but cannot replace biologists trained in data-driven computational analysis. An evaluation of SV carried out in 2016 concluded that: “Just IC [computer science] joint positions are very unlikely to serve SV’s needs; much of computational biology requires considerable creativity in how to frame and manipulate data to generate biological insight, but there is little methodological/algorithm-based research, which is what IC-related positions will need.”

As a result, we plan to build up our skills in CompBio and anchor this topic in both education and research. We believe that CompBio provides a framework for life-science research that is data-driven, quantitative, theoretically sound, statistically robust and highly innovative. Glimpses into how CompBio is starting to shape the future of life sciences can be found in the fields of quantitative cell and developmental biology, single cell biology and genomics, and data-driven approaches to human health such as digital epidemiology and human-microbial communities. Therefore we would like to transform the EPFL status quo in this field through the addition of new chairs for emerging and established figures in CompBio. At EPFL, we benefit from a crucial and almost unique advantage: the close physical proximity (i.e., on the same campus) of world-class life-science, computer-science and basic-science facilities. As such, we have all the ingredients to create an interactive and stimulating environment for excellence in CompBio through the strategic hiring of key figures in this emerging field.

Regarding our degree programs, we intend to incorporate CompBio subjects through new classes and specific tracks at the Bachelor’s, Master’s and PhD level. The goal will be to train life scientists on all stages

of the data-science pipeline, from data generation, collection and handling to data analysis using new computational methods such as those based on machine learning and artificial intelligence. This will entail building bridges between fundamental engineering, in which EPFL excels, and cutting-edge computational biology. Life-sciences graduates with strong skills in computational methods and data-intensive analyses are in high demand at universities, businesses and startups, including many of those in the Lake Geneva region. Our region attracts more than 70% of the tech investment in Switzerland – most of which goes to the healthcare industry – and this trend will only increase, especially given how important life science industries are to the Swiss economy. Our graduates will thus be well-equipped not only to leverage big data for the benefit of modern life science, but also to meet the rapidly growing demand from industry, helping to secure Switzerland's prominent position in the life sciences. Importantly, jobs in biology and healthcare attract high percentages of female graduates. A strong commitment by EPFL in these fields would not only strengthen our school and our country's economy, but also help draw more women to careers in science and engineering.

In light of how rapidly the life sciences are changing in response to big data and leaps in computing power, we must act swiftly and decisively if we are to prevent a strategic weakness from forming at EPFL. This was pointed out very clearly in the 2016 evaluation of SV, warning that: “In some research areas the capacity falls short in making a significant impact. To remedy this, substantial expansion is required in the area of computational biology. In the long run, probably ten principal investigators will be needed in this area.”

Synthetic biology: The engineering of living systems

Living systems have an amazing capacity

for precision synthesis, manufacturing, decomposition and self-reorganization into complex structures at different levels (molecular, cellular and tissue). In addition, biology has become increasingly easy to engineer; for example, DNA synthesis, even at a genome scale, is within reach. There is almost no limit to the potential applications of synthetic biology. Some of the most promising ones are:

- new frontiers in human medicine: engineered cells or cellular assemblies that can sense, diagnose, prevent and treat diseases, and functional tissues for drug discovery and regenerative medicine
- new frontiers in manufacturing: biological manufacturing systems that operate under normal environmental conditions, are sustainable, require low power and can generate high-value products
- bioremediation: engineered organisms that can decontaminate water or soil of toxic chemicals that cannot be removed by existing means
- information technology: data storage and processing through DNA encoding and protein manipulation.

Synthetic biology is a cross-disciplinary field drawing on skills from bioengineering, biology, physics, chemistry, materials engineering, mechanical engineering, electrical engineering, computer science and more. Under the 2021–2024 strategy, we plan to build on our existing strengths (both theoretical and experimental) in molecular biology, biophysics and quantitative biology to understand and manipulate complex living systems. This could be carried out through a joint venture involving all EPFL schools and would require hiring experts in synthetic biology, especially for single cell organisms. As

an engineering school, EPFL offers an excellent environment for education, and

the combination of engineering and life-science skills is in high demand in industry.

9.6. CDH - COLLEGE OF HUMANITIES

Following the evaluation of our school in 2017, we spelled out a new, compelling vision for education, research and public engagement in the 21st century. To implement our vision, we suggested that each of those three areas be addressed using a holistic approach, called “POLY-perspectives,” based on the four interconnected pillars of interdisciplinarity, global awareness, responsible citizenship, and creativity. Under the 2021–2024 strategy, we will further implement our vision, and all our efforts – be they in terms of education, research or public engagement – will directly address at least two of these pillars. The goal is to promote a holistic view of today’s main societal and technological challenges and facilitate collaboration among the human and social sciences, engineering, life science and other fields to build a sustainable future.

awareness about societal issues and add leadership skills to their scientific know-how.

Under the 2021–2024 strategy, we will develop additional Bachelor’s and Master’s classes that take an interdisciplinary approach to major global topics such as big data and society, personalized medicine, humans and technology, and sustainable development. Some of these classes will be taught jointly by professors from both engineering and the human and social sciences. The classes will also impart knowledge and skills in project management, legal affairs, research and engineering ethics, teamwork and group dynamics. This will prepare students to address the ethical challenges stemming from advancements in science and technology and give them a heightened sense of social responsibility.

EDUCATION

Our primary mission at CDH is to provide leading-edge degree programs in the human and social sciences at both the Bachelor’s and Master’s level. We currently offer around 150 courses on a wide range of topics, which are taught by some 120 lecturers who mostly come from the University of Lausanne, the University of Art and Design Lausanne (ECAL) and the Geneva University of Art and Design (HEAD).

Our degree programs are designed to help scientists and engineers incorporate human and societal factors into their work, give them a more comprehensive understanding of today’s world, build their

We will develop prototype classes in the human and social sciences through an initiative inspired by the Fab Foundation, an organization spun out of MIT’s Center for Bits & Atoms Fab Lab Program in 2009. By testing out innovative teaching methods, this initiative will allow our school to promote the dissemination of novel, effective teaching practices in our degree programs as well as in other interdisciplinary programs at EPFL.

Finally, we will enhance our Master’s and PhD programs in digital humanities by forming partnerships with other universities in Switzerland and abroad (along the lines of our existing partnership with the University of Lausanne), taking a strategic approach to hiring, offering internships at prestigious

institutions around the world and setting up international summer school programs at EPFL.

RESEARCH

The Digital Humanities Institute that we created in 2015 has already become one of the most famous research centers of its kind in Europe, and its scientists have obtained prestigious grants (e.g. ERC, VolkswagenStiftung and H2020). The institute is a good example of the interdisciplinary approach taken at EPFL, which combines a strong foundation in engineering and the social sciences with research that goes beyond traditional boundaries.

Under the 2021-2024 strategy, our research efforts will focus on:

- exploring new programming languages for audiovisual content that allow information to be encoded effectively and that compile data from different types of sources. This research focus comes in response to the ubiquity of audiovisual media today, with 70% of internet traffic made up of videos. The research would be conducted in association with other EPFL schools, ArtLab and the RTS.
- rolling out additional joint projects between our two institutes: the Institute for Area and Global Studies and the Digital Humanities Institute.
- furthering our collaboration with the new dhCenter, an interdisciplinary research center in digital humanities and digital scholarship set up by EPFL and the University of Lausanne. In 2019, we launched the Lausanne Time Machine Project in collaboration with the dhCenter. This research program aims

at compiling different kinds of data about Lausanne's history – from population statistics to maps of urban morphology – and use digital technology to analyze the data and generate a geo-historic platform depicting our city's growth. This program will entail working closely with the City of Lausanne and the Canton of Vaud, especially with regards to innovative methods for teaching high-school students about the digital humanities.

PUBLIC ENGAGEMENT

In terms of public engagement – which is closely tied to our teaching and research activities – our efforts will build on our natural role at EPFL to lead citizen initiatives such as action-research programs, citizen science platforms and public debate on key issues such as the impact of digitalization on society. We will address two topics in particular:

- Philosophy and Technology: Growing awareness about how social media is affecting democracy, for example, or about the importance of climate action, reflect the increasingly predominant role that technology and automated processes are playing in how consumers and policymakers get their information and, crucially, make decisions. At CDH, we intend to play a central role in fostering public debate on these types of philosophical issues arising from recent advancements in technology and neuroscience. We will also promote teaching and research on ethics in science and engineering across EPFL. Over the coming years, we intend to hire postdocs conducting research at the crossroads of philosophy and computer science. We will also seek to create a new joint faculty position in ethics between

EPFL and the University of Lausanne in response to the findings of an in-depth report conducted in 2018 on ethics education at the two universities.

- Art-Sciences: We will promote an academic vision of the arts that combines education, research and public engagement. Our ArtLab center provides a platform for both EPFL and the general public to engage in debate about key issues affecting the arts, humanities and science. It supports the holistic perspective we are taking at our school as well as EPFL's broader missions of education, research and innovation. Under the 2021-2024 strategy, ArtLab will further its efforts in data archiving, data exchange and identity. The center has appointed a Scientific Committee and an International Advisory Board to ensure its programs remain of relevance to EPFL and continue to meet world-

caliber standards. Two other strategic priorities for ArtLab are audience-building and fundraising, the latter of which is actively ongoing; the center will also strengthen its brand image through a revamped communications strategy. ArtLab is involved in a variety of joint programs with local and regional stakeholders. For example, through its seminal Montreux Jazz Archive project, the center is showcasing EPFL's leading role in archiving science. ArtLab's Pavilion B serves as an experimental platform for exhibitions and debates in the humanities, sciences and arts for the EPFL community and the public at large. We plan to remodel Pavilion A (DataSquare) to reflect the cutting-edge research being done on our campus as a whole, while keeping space available for timely debates and temporary exhibits of important innovation projects.

9.7 CDM - COLLEGE OF MANAGEMENT OF TECHNOLOGY

MISSION

CDM offers degree programs and conducts research in the fields of management, economics and finance. Because we are housed within EPFL – a school of science and engineering – we are able to offer more than a “standard” business school is able to provide. We aim to position ourselves for the future of management education by combining the traditional disciplines of a business school with the core subjects taught at a leading technical university. Our three main strategic objectives are to:

- train tomorrow's business leaders by giving students fundamental skills in management, economics and finance as well as an intellectual background in engineering. This will help EPFL

graduates access top management positions.

- conduct fundamental and applied research in our core fields, since CDM is principally an academic institution focused on specific disciplines (and is assessed according to our contribution to those disciplines).
- further expand our course offering and research to include fields in science and engineering. This will enable us to fully leverage the opportunities at EPFL for synergies and joint R&D. Specific subjects we plan to address are fintech, innovation analytics, business and supply chain analytics, operations

research, social entrepreneurship, sustainable technology management, and policy. We will also help develop innovative degree programs at the crossroads of our core fields and science and engineering, at both the undergraduate and graduate level.

CHALLENGES

The biggest challenge our school currently faces relates to our first objective: sharing our knowledge and skills in management, economics and finance across EPFL. Here the main opportunities lie in revamping our existing programs and offering a series of Bachelor's level introductory classes in management, economics and finance. This would entail only a handful of classes but would be a major step forward in achieving that objective, delivering benefits not only to students wishing to pursue careers in one of our fields, but also to all other students, as they will gain exposure to these important subjects. Setting up these classes would require significant additional resources.

Another major challenge we face is stepping up our research efforts in areas that incorporate new technology. This includes developing methods, tools and research agendas combining computational social science with economics – an emerging field at the crossroads of data science and our core fields.

PRIORITIES

As we strive to meet our objectives, we must be careful not to spread our resources too thin, which would prevent us from delving deeply into any one given subject. We should therefore concentrate our efforts on our core fields, with programs reflecting our many unique strengths – finance, innovation, entrepreneurship,

operations research, and policy – and how they can be applied in response to today's societal and technological challenges. More specifically, we intend to develop the following areas:

- fintech: conducting research and leveraging applications that draw on advancements in finance and technology
- innovation analytics: taking the intellectual lead in developing “big indicators” for innovation and studying emerging economics and the strategic management of artificial intelligence
- business and supply chain analytics and operations: developing tools and methods that will provide a scientific foundation for data-driven decision processes, which are being adopted rapidly in both the public and private sectors
- social entrepreneurship, development and sustainable management: conducting research and leveraging applications that address the key societal challenges of our time
- policy: forming a research agenda that looks at how technology can serve the public interest, which is a central issue at a school like EPFL.

IMPLEMENTING THE STRATEGY

Our 2021-2024 strategy will be implemented in the following stages:

1. Setting up a series of Bachelor's level introductory classes: We have already started outlining these classes and determined the additional resources that could be made available by better coordinating and combining existing programs. We are also restructuring our

executive education program to make it more flexible and proactive, and we are improving our Master's programs through joint initiatives with the School of Engineering and the School of Computer and Communication Sciences.

2. Hiring additional faculty: We will hire additional professors in operations research, business analytics and financial data science in the near term, and in finance, innovation, policy, development and sustainability later on. This, combined with our participation in a joint initiative with UNIL and IMD on sustainable management, will make us better able to carry out our educational and research activities.
3. Further incorporating our research into the other science and technology research being conducted at EPFL: This will include participating more

fully in key strategic initiatives (like C4DT and complex systems), creating a fintech lab, working more closely with experts in machine learning and big data and consolidating EPFL's activities in social entrepreneurship and development (these topics are studied in different programs across EPFL but without clear coordination or academic leadership).

Under the 2021-2024 strategy, we will further our research efforts in our core fields; begin offering a series of Bachelor's level introductory classes in management, economics, and finance; and extend our reach across EPFL through initiatives that sit at the crossroads of our core fields and science and engineering. In short, we will continue to build a unique business school, of average size but with exceptional relevance and impact for a university like EPFL.

9.8. EPFL MIDDLE EAST

Between 2009 and 2020, EPFL Middle East worked to establish a solid track record of innovation and impact in the United Arab Emirates (UAE) in various fields pertaining to energy and sustainability. The EPFL Middle East campus – entirely funded by the local government (at no net cost to EPFL or Switzerland) – exemplifies the innovation potential of graduate-level research and innovation. To date, the campus has offered 150 Master's level internships and thesis projects in the UAE, with several technology transfers to both the public and private sectors. The impact of EPFL Middle East can be summarized in five key metrics:

- a ratio of economic return on investment higher than 3:1, over less than ten years

- over 100 new jobs created in the UAE as a result of local technology transfers
- local carbon abatement that should reach over 200,000 tCO2/year by 2021, in completed and validated or pending projects
- over 200 scientific peer-reviewed publications and conference articles (master and PhD level)
- the training of over 150 engineers in energy management and sustainability, half of them currently employed in the energy sectors of Europe and Switzerland.

Under the 2021-2024 strategy (and beyond), we will build on these foundations

and widen the scope of EPFL Middle East by:

- introducing a Master's in Energy Science and Technology program, which will involve adding classes in energy systems and energy conversion devices to the energy management and sustainability classes already on offer. This program will also support the energy transition underway in Switzerland.
- adding new research areas and their applications in fields such as applied digital technology (e.g., data science, digital humanities and civilian cybersecurity), the fundamental sciences and other scientific and engineering disciplines (e.g., aerospace, infrastructure and educational technology).
- setting up collaborations with the best local universities offering Master's programs. We hope to attract many of the qualified Emirati students who are currently being sent to the US or UK for graduate school. As part of these efforts, we will expand our local internships and Master's thesis projects, extending our impact beyond education and into innovation.
- enhancing our executive education programs and developing a regional platform for MOOCs and other lifelong learning programs, for both alumni and other stakeholders.

- creating an innovation support program to share our know-how in technology transfer and entrepreneurship and help establish a local innovation ecosystem. This ecosystem will in turn support EPFL graduates as they transfer their ideas to industry or use them to launch new businesses. It could also provide a gateway for Swiss startups looking to penetrate Middle Eastern markets out of the UAE.

This strategy is designed to make EPFL Middle East an expanded platform for innovation and bridge the gap that currently exists between local businesses and universities. Our funding sources will not change relative to 2009–2020, as our essential base funding will continue to be provided by the local government (Emirate of Ras Al Khaimah and Federal UAE Ministry of Education). However, as we implement this strategy, the Emirati government could become interested in further expanding our relationship to include exchange programs and local investment at the PhD level, such as through local research facilities funded, and owned by the local government – a proposal that we may consider in due course.

