ETH BOARD

Intermediate Evaluation 2015
of the ETH Domain

Self-Assessment Report

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Adopted by the ETH Board on December 11, 2014

ETH zürich

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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EMPA Materials Science & Technology

eawag aquatic research

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Foreword by the President of the ETH Board

"As a driving force for innovation, the ETH Domain wishes to strengthen Switzerland's long-term competitiveness through excellence in research, teaching and knowledge and technology transfer, and to contribute to the development of society. Acting as a beacon, it will seek to assume its share of global responsibility for tackling urgent social challenges, for improving quality of life and for the long-term preservation of the resources our lives depend on."

This is the Vision Statement of the ETH Domain, which has guided our two Federal Institutes of Technology and the four Research Institutes in the recent past and which has been redetermined by the ETH Board in the context of its Strategic Planning 2017-2020. It is precisely the key elements of this vision which are at the core of the mandate attributed to the international expert committee for the intermediate evaluation 2015 of the ETH Domain: its Terms of Reference deal with the role played by the ETH Domain institutions in higher education policy as well as in economic and innovation policy in Switzerland. They thus focus on the contributions of the ETH Domain to several crucial areas with regard to Switzerland's prosperity and its sustainable development, namely their contributions to our country's innovation capacity and to its world-class higher education system.

In previous years, the intermediate evaluation focused primarily on scientific achievements. Evaluating the ETH Domain's academic performance means moving on safe grounds: it is commonly recognized that the institutions of the ETH Domain have achieved a world-leading level both in research and in teaching. With its adapted focus, however, we see the current intermediate evaluation both as a challenge and as an opportunity. The challenge is to leave the above-mentioned safe grounds of a scientific evaluation with its proven methodology and its well-established criteria, and to take position, for instance, on various topics which are subject to discussions not only within the scientific community, but also in politics, the economy and the society as a whole. At the same time, this evaluation offers the opportunity to reflect on the manifold direct and indirect ways in which our institutions contribute to and strengthen the Swiss economy, the country's (higher) education system and its attractiveness as a center for science, innovation and technology. This entails the opportunity to benefit from the expert group's recommendations upon which the ETH Domain will be able to further develop and to foster the leading role it intends to play.

Recognizing these opportunities, the ETH Board has tackled the challenge most seriously. Together with the institutions of the ETH Domain and in a self-critical attitude, we identified and assessed for each of the Terms of Reference the relevant strengths and weaknesses, from which we derived a comprehensive analysis of middle- and long-term perspectives of the ETH Domain.

Doing so, we are able to draw a differentiated picture of the ETH Domain's successful work in the various fields addressed by the performance mandate of the Federal Council and of the ETH Domain's contributions to the sciences, the economy and the society as a whole. The present Self-assessment report of the ETH Board has been established with this aim. In the name of the entire ETH Board I hope it will contribute to a thorough examination and critical review of the ETH Domain. We look forward to receiving the expert committee's most valuable recommendations.

Dr. iur. Fritz Schiesser

Introduction

Introduction

Evaluation Mandate and Structure of the Self-Assessment Report

Evaluation Mandate

The intermediate evaluation of the ETH Domain is part of the performance mandate of the Federal Council to the ETH Domain for the period 2013–2016. The performance mandate states: "The department will carry out an evaluation of the performance of the ETH Domain in mid-2015 for which it will draw on external experts. The ETH Board will state its position on the evaluation report. The evaluation report and the position of the ETH Board will form the interim report, which will be forwarded to the Federal Assembly together with the proposal for the next performance period (Art. 34a ETH Law)."

Unlike in previous years, the 2015 intermediate evaluation shall not focus on the scientific achievements of the ETH Domain institutions. Rather, the evaluation mandate attributed to the expert group in charge states: "The expert report to be drawn up here should, in contrast, focus in particular on the role played by the ETH Domain institutions in higher education policy and economic and innovation policy in Switzerland. The experts are invited to assess performance in the current period (2013–2016) and, in addition, to consider how the ETH Domain can position itself and develop in the context of the coming changes. They should take account of the potential tension between the ETH Domain's competitiveness on the international stage and its position and role in Switzerland across the range of ETH Domain activities."

Structure of the Self-Assessment Report

Correspondingly, the evaluation mandate contains 13 Terms of Reference to be addressed by the expert group. As a first step, the ETH Board has elaborated a Self-Assessment Report, presenting the ETH Board's view on each of these Terms of Reference. As the performance mandate requires, the Self-Assessment Report shall also supply bibliometric data that it is not possible to collect annually. Therefore, the Self-Assessment Report of the ETH Board is structured as follows:

- The Introduction presents an analysis of current strengths as well as future opportunities and challenges which aims at systematizing, on a comprehensive level, important aspects regarding the mid- to longer-term development perspectives for the ETH Domain and the individual institutions, as set out below with regard to the individual Terms of Reference of the evaluation mandate.
- The main part of the present report (chapters A–D), answers each term of the Terms of Reference (ToR) separately (following the structure of the ToR, subdivided in sections A.1–D.2). Each section is preceded by an assessment statement of the ETH Board, presenting assets as well as challenges and opportunities with regard to the particular question(s) raised. Following the assessment statement, the section discusses the position put forward in the statement and presents the evidence for the view expressed by the ETH Board.
- Chapter E summarizes the bibliometric analysis that has been executed in the context of the present intermediate evaluation. For the reporting on the fulfillment of the performance mandate, the ETH Board suggests referring to the Annual Reports on the ETH Domain, and in particular to the "insight" section of the 2013 Annual Report, which is reproduced as an appendix to the present Self-Assessment Report, as well as to the

corresponding section of the 2014 Annual Report, which will be submitted to the expert committee after its adoption by the ETH Board on March 5, 2015.

– Chapter F presents the statement of the ETH Board on the follow-up of the experts' recommendations of the 2010 intermediate evaluation and the Executive Summary of the ETH Board's Strategic Planning 2017–2020 for the ETH Domain. The Strategic Planning is being elaborated simultaneously with the Self-Assessment Report and represents an important additional source of information for the experts' evaluation.

Perspectives of the ETH Domain

As mentioned above, the Terms of Reference (ToR) seek not only to evaluate the ETH Domain's role in higher education policy and economic and innovation policy in Switzerland. They also raise the question as to how the ETH Domain can and will develop in light of the changes to be implemented in the Swiss political framework, but also with regard to the development of the global environment.

In the present report, the ETH Board summarizes its answers to each of the ToR (chapters A–D below). In the context of and with reference to these ToR, the following chapter provides a comprehensive view of the issues most relevant for the development of the ETH Domain and its institutions in the medium and longer term, by addressing the core current strengths and weaknesses as well as the primary opportunities and challenges/threats for the future of the ETH Domain.

The elaboration processes of the present Self-Assessment Report and the ETH Domain's Strategic Planning for 2017–2020 run concurrently. In the Strategic Planning, the ETH Board presents its vision for the development of the ETH Domain. It addresses the framework conditions and the resources the ETH Domain requires if, within the framework of the mission assigned to the ETH Domain by the Confederation, it is to fulfill the ambition laid down in the vision statement. The vision statement and the corresponding outlook formulated in the Strategic Planning are therefore part of the background upon which the following assessment of strengths, weaknesses, opportunities and challenges/threats is produced.

In the Strategic Planning 2017–2020, the ETH Board has formulated the following vision statement: "As a driving force for innovation, the ETH Domain wishes to strengthen Switzerland's long-term competitiveness through excellence in research, teaching and knowledge and technology transfer, and to contribute to the development of society. Acting as a beacon, it will seek to assume its share of global responsibility for tackling urgent social challenges, for improving quality of life and for the long-term preservation of the resources our lives depend on."[1]

Strengths

The following characteristics represent particular strengths of the ETH Domain and its institutions:

– *Unique features:* The ETH Domain is characterized by powerful unique features *(Alleinstellungsmerkmale)*, allowing a world-class positioning of all six institutions while maintaining distinct profiles. The domain structure has had a positive impact on the institutions' fundamental interdisciplinary orientation and allows the ETH Domain to perform fundamental research at the highest possible level and application-oriented research driven by the demands of industry and society, as well as to provide world-class teaching based on the research performed. The unique features of the ETH Domain are the following:

[1] See chapter F.2 below for the Executive Summary of the Strategic Planning 2017–2020.

  - The *combination of exact, natural and engineering sciences and their association with social science and humanities (including economics)*: The ETH Domain is the only actor in Switzerland capable of offering such a wide range of specialization with the corresponding research and teaching activities. The resulting interdisciplinary network of competencies is key for the ETH Domain's capacity to provide solutions – in its areas of research – to the complex social, political and economic challenges of our time.
  - The *complementary relationship between the two Federal Institutes of Technology and the four Research Institutes:* The complementary character of the ETH Domain institutions and their areas of specialization yields powerful internal synergies, these being an important part of the ETH Domain's strong current and future position. While the two Federal Institutes of Technology, i.e. ETH Zurich and EPFL, are engaged in teaching based on the world-class (and mostly fundamental) research they perform, as well as in intense Knowledge and Technology Transfer (KTT) activities, the four Research Institutes, i.e. the PSI, WSL, Empa and Eawag, specialize in top-level thematic research as well as applied research in their focal areas, and in technology development. Together, the six institutions cover the entire value-added chain from basic research and teaching to applications of new knowledge.
  - The *internationally renowned research infrastructures of national importance* hosted by the ETH Domain institutions: The portfolio of the major research facilities in the ETH Domain is of exceptional importance to the innovative, solution-related advancement of cutting-edge research. Many of its highest-standard and state-of-the-art (large-scale) research infrastructures are operated as user labs, allowing researchers from Switzerland and abroad to use this unique infrastructure, which is made accessible by the Confederation through the ETH Domain institutions (→ for further information on these unique features, see Appendix 1).

- *Innovation ecosystem:* Together, the six institutions of the ETH Domain are able to offer a genuine innovation ecosystem. This covers the entire range of activities from education and science-based training of future specialists to intensive collaboration with industry partners, political authorities and the public administration. It is by offering such an innovation ecosystem that the ETH Domain delivers its most important contributions to the Swiss economy and Swiss society (→ see parts A.1 and A.2 for details).
- *Attractiveness:* Thanks to the high degree of autonomy the institutions enjoy, the attractive work conditions they are able to offer and the general support for the globally oriented scientific research and development that has characterized Switzerland up to now, the institutions of the ETH Domain are capable of attracting the best researchers and (young) academics worldwide, irrespective of their origin, gender or age. This has allowed the institutions of the ETH Domain and their researchers to develop an outstanding global competitiveness – as measured, for instance, by the ETH Domain's success in obtaining a large number of the prestigious grants of the European Research Council (ERC grants). The institutions thereby contribute to the overall strengthening and development of the Swiss higher education system (→ see parts B.1., B.3, and C.3 for details).
- *Trendsetter role:* In many fields, the ETH Domain institutions have seized the opportunity to play a trendsetter role. This applies to topics that are investigated before they become a central focus of politics and society as well as within the scientific community (e.g. in energy research). It holds also with regard to organizational or infrastructural aspects through which the institutions of the ETH Domain contribute to shaping the academic landscape of the future within and outside Switzerland (e.g. in the development and training of young academics, teaching, or large-scale research infrastructures). This applies also to the institutions' activities in the field of KTT – as can be seen, for instance, in the best practices developed by the ETH Domain institutions in the area of KTT (e.g. with regard to the successful

positioning of the ETH Domain spin-offs, their above-average survival rate, the many prizes they are awarded, and their attractiveness as highly sought-after acquisition targets for big corporates [→ see parts A.1, A.3, B.2 and C.2 for details]).

- *Sustainable growth:* The growth of the ETH Domain institutions is a clear answer to the needs of Switzerland in terms of graduates, professionals and leaders in science and technology. Access to both ETH Zurich and EPFL is granted to Swiss students – having obtained the Matura school-leaving qualification – on the one hand, while on the other hand the increase in the number of foreign candidates is controlled by the institutions through the current legal framework. In this sense, growth can represent a way of responding to the demands of the dynamic and globally oriented environment within which the institutions of the ETH Domain evolve. The ETH Board must therefore constantly pay attention to the governance of the ETH Domain so that it allows the institutions to grasp opportunities for growth while also exerting an adequate degree of strategic control and effectively assessing the risks of the institutions' corresponding activities (→ see parts C.1 and C.2 for details).
- *Collaboration within academia:* The ETH Domain institutions have engaged in intensive collaboration with partners not only from industry but particularly from other academic institutions within and outside the ETH Domain (in particular universities, but also Universities of Applied Sciences, in Switzerland and worldwide). The (large-scale) research infrastructures hosted by the ETH Domain institutions, many of them unique in Switzerland, represent a particular asset in this regard. These infrastructures, however, not only attract scientists from public and private research institutions but act also as a driver for innovation and the generation of specialized knowledge. The fact that the ETH Domain institutions have acquired a strong reputation as attractive cooperation partners for excellent scholars worldwide increases the benefit they can offer to collaboration partners in Switzerland (→ see parts B.2, C.3, C.4, C.5 and D.1 for details).
- *Collaboration with the private sector:* The ETH Domain institutions have been able to engage in fruitful and trustful relationships with actors from the private sector. This has not only enabled them to attract companies to the campus and to increase their outreach in terms of KTT. They also attract funding and in-kind contributions from these partners, both with regard to scientific and to infrastructure projects (funding of research activities and chairs, PPP arrangements in real estate projects). And, most importantly, they can mutually benefit from the exchange between industry and academia, which proves to be very fruitful for both sides. Encouraged by the Confederation, these third-party funds have become an important source of income for the ETH Domain and a valuable means of enhancing the institutions' capacity to flexibly set research priorities (→ see part B.1 for further development).

Weaknesses

The ETH Board identifies the following weaknesses:

- *Internal acceptance of professionalization:* The institutions of the ETH Domain benefit from the great commitment of all employees to serving their strategic objectives. Increased specialization and professionalization in all areas, including the administrative, supportive and technical services enabling top-level research, also takes place within higher education and research institutions. However, the value of such enabling work and, in particular, the level of professionalization achieved are not always sufficiently acknowledged within the institutions. All their affiliates must adequately value such professionalization and see it as adding value to their core activities and interests.

– *Communication:* The ETH Board and the ETH Domain institutions are still failing to sufficiently communicate the role they play for innovation and economy in Switzerland – as well as their strategic objectives in serving society as a whole – to their stakeholders, the general public and the political actors who determine the framework within which the ETH Domain institutions operate. Instruments must be used – or, where relevant, developed – for proactively sensitizing public opinion to the importance of the ETH Domain's role in ensuring the prosperity of Switzerland and its economy. This will help to create additional awareness for the importance of success factors such as openness and international embedding and will build trust toward the institutions that public funding, from which they benefit, is effectively used.

Opportunities

The following aspects represent particular opportunities for the ETH Domain, resulting at least in part from the above-mentioned strengths and the current successful positioning of the ETH Domain institutions:

– *Autonomy:* Rooted in the Federal Act on Federal Institutes of Technolgy (FIT or ETH Act)[2], the autonomy granted to the institutions of the ETH Domain – which entails the freedom to allocate their resources independently – is fundamental to the definition and implementation of new strategic projects which will be relevant tomorrow for the ETH Domain and for Switzerland as an academic and economic focal point in Europe. Autonomy, in this regard, entails the freedom to explore novel and innovative scientific fields. Their capacity to act autonomously in a strategic and entrepreneurial spirit is clearly a strength of the ETH Domain's institutions and must be preserved for the future (→ see part B.1 for further development).

– *Framework conditions:* Many of the ETH Domain's opportunities, but also the challenges with which the institutions will be confronted, are not specific to these institutions but affect all higher education and research institutions in Switzerland. All actors in higher education and research in Switzerland must therefore make a joint effort to defend and secure the favorable framework conditions, such as the current extent of autonomy, from which research, science, and innovation benefit. Thanks to these excellent framework conditions, the institutions of the ETH Domain and the ETH Board are in a position to further grasp the competitive advantage these conditions confer, in particular in comparison with both European and non-European countries. This competitive advantage results, for instance, from Switzerland's present economic situation and from its stable legal and political environment (→ see part B.1 and C.3 for details).

– *Role of the ETH Domain in biomedical research and technology:* Translational medical research is set to represent an increasingly important part of medicine as a whole this century. With their world-leading research infrastructures and the associated experience, and with their powerful partnerships with (university) clinics both at Zurich (as well as Basel) and Lausanne/Geneva, the institutions of the ETH Domain have the capacity to develop and support innovative medical technology and to educate and train research-oriented medical scientists. They are thus justified in their ambition to play a major role in the future development of medicine, biomedical research, medical technology and the healthcare system in Switzerland. As many of these developments are determined by political decisions on various levels, the ETH Board must continue to demonstrate the added value that is generated by an increasing involvement of the ETH Domain institutions in the medical field (→ see parts D.1 and D.2 for details).

[2] See SR 414.110, http://www.admin.ch/opc/de/classified-compilation/19910256/index.html.

Challenges and Threats

The following aspects represent particular challenges with which the ETH Board, as well as the individual institutions of the ETH Domain, will be confronted in the near future.

- *HEdA governance:* Under the new governance of the Higher Education Funding and Coordination Act (HEdA)[3], taking effect as of January 1, 2015, the working relationships with the Federal Council and the Federal Administration will become all the more important. It will be essential for the entire ETH Domain that the ETH Board interacts fruitfully with the member of the Federal Council that represents the Confederation – including the ETH Domain – in the Conference, as well as with the other full members of the Conference. The aim must not only be to ensure that the ETH Domain's interests are taken into account in the decisions taken within the HEdA governing bodies, but also to offer the corresponding bodies the opportunity to benefit from insight and expertise available within the ETH Domain. Particular attention must also be paid, in the context of the new HEdA governance, to increasing requirements for coordination among the institutions and to maintaining distinct profiles between universities and Universities of Applied Science (→ see part B.1 and C.4 for further development).
- *Access to international networks and openness:* Internationality and openness represent core success factors of the Swiss academic system and are realized prominently within the ETH Domain. An important element of the world-class positioning achieved by the ETH Domain institutions is that they are able to recruit the best researchers worldwide. As a scientific location, Switzerland has always been characterized by a culture of openness and accessibility, enabling scientists from Switzerland, in turn, to gain work experiences abroad, to compete in the international academic environment, and to participate in international networks, which are of increasing academic importance. This is why there will always be a tense relationship between the institutions' fundamental international orientation and the assignment of roles and tasks on the national level. At present, however, there are uncertainties as to whether this culture of openness – and hence the links to international (and especially European) research collaboration initiatives as well as the attractiveness of Switzerland for top-level scientists from around the globe – can be maintained at the current level. This seriously affects the outlook for the country and its scientific community. Therefore, the ETH Board and the institutions must seek all the more to sensitize the population and the authorities to the value of openness and, in particular, to the crucial importance of Switzerland's full participation in the Horizon 2020 framework program of the European Union. Again, this represents a field in which all actors involved must join forces in order to defend Switzerland's scientific and economic interests (→ see parts B.1 and C.5 for further development).
- *Student numbers and quality of students:* Although demographic trends currently point to slower growth in the ETH Domain institutions, in particular the two Federal Institutes of Technology, growth in student numbers and the quality of the students remain a challenge to be carefully addressed. The recent decision of the Swiss High Court regarding the implementation of the Lisbon Agreement[4] has raised the question as to whether the ETH Domain institutions need additional legal instruments allowing them to control student numbers at bachelor entry level. Having decided to propose a corresponding amendment of the ETH Act to Parliament in the context of the next ERI Message, the ETH Board will have to prepare for the necessary political debate and the potential implementation of the new legal provisions. The main purpose of this measure will be to ensure that the two Federal Institutes

[3] See SR 414.20, http://www.admin.ch/opc/fr/classified-compilation/20070429/index.html.
[4] See the Convention on the Recognition of Qualifications concerning Higher Education in the European Region: http://coventions.coe.int/Treaty/en/Treaties/Html/165.htm.

of Technology remain in a position to select the best foreign students, which represents an important aspect of their ambition to be among the world's leading universities. With regard to the quality of the students, and in particular concerning their competencies in the MINT disciplines (mainly mathematics) at bachelor entry level, attention must also be directed towards Swiss students. The two Federal Institutes of Technology have set up instruments helping prospective students to assess their level of competence on a voluntary basis and to choose from a number of supportive offers (including online tools and MOOCs[5]) before or during their first year of study. Nevertheless, further efforts will also need to be deployed to ensure that the Matura school-leaving qualification will continue to guarantee that students have a solid grounding in mathematics and other MINT disciplines, allowing them to succeed in a competitive environment such as the two Federal Institutes of Technology. This is all the more important in the context of the current joint efforts, which the ETH Domain fully endorses and supports, to tackle the lack of qualified MINT personnel (Fachkräftemangel) in Switzerland (→ see part C.2 for further development).

- *Maintaining favorable framework conditions:* In order to sustain and defend the favorable framework conditions from which the ETH Domain institutions and the Swiss higher education and research system benefit, the ETH Board will emphasize the crucial importance of the institutions' autonomy (academic and financial) as one of their key success factors and will play an active role in the corresponding political debates. On the other hand, it must ensure that the institutions act upon solid principles of good governance. This will be of key relevance in order to avoid increasing regulation of matters concerning the ETH Domain and the scientific community as a whole. Similarly, the good working relationship that the ETH Board and the ETH Domain institutions enjoy with their owner – the Federal Council, Federal Parliament and Federal Administration – must be maintained and further cultivated (→ see part B.1 and C.3 for further development).
- *Lack of predictability:* The fast-moving dynamic of the sciences and of the (scientific) environment in which higher education and research institutions evolve, as well as changing demands from society and politics, make it inherently difficult to project and thus strategically orient the focal points of the institutions' development on a mid-term view. The ETH Board and the institutions must therefore ensure that their strategic planning and strategic controlling instruments create the necessary freedom with regard to the unpredictability by which science is inherently characterized (→ see part A.2 and C.2 for further development).
- *Geographic expansion:* Concerning the geographic expansion of the ETH Domain, the ETH Board estimates that the current processes of regional expansion at the national and international levels – which are limited both in scope and number – present opportunities that clearly outweigh the risks. However, both the ETH Domain institutions and the ETH Board must apply consistent strategic criteria for assessing and controlling expansion projects. This will balance the opportunities and risks in a way that ensures the sustainability of such expansion endeavors (→ see part C.1 for in-depth development).
- *Reliable basic funding:* With regard to the size of the institutions, the ETH Board and the institutions will also have to insist on the crucial importance of the reliable and comprehensive basic funding which is granted to the ETH Domain and thereby ensure its continued existence. This challenge is clearly important in the context of the HEdA governance and the current efforts to further strengthen the dual education system in Switzerland – efforts that are fully supported by the ETH Domain (→ see part C.4 for further development).

[5] MOOCs = Massive Open Online Courses.

- *Balance between funding sources:* Attention must also be paid to the balance between funding sources. The appropriate proportion of second- and third-party funding[6] may vary from one institution to the other and from one research field to the other. Both the institutions and the ETH Board must make sure that a healthy and sustainable balance between funding sources is maintained. Adverse effects of imbalances may on the one hand mean that first-party funds are increasingly tied up by insufficient overheads allocated in second-party funded projects (= indirect costs) or by the need to make up missing funds in a matching funds scheme. This would clearly impair flexibility for curiosity-driven fundamental research, which is of prime importance in the promotion of innovation. On the other hand, such an imbalance would heighten the risk of external actors increasingly determining the strategy of the institutions through the orientation of the research projects they fund (→ see part A.2 for further development).
- *Funding from the private sector:* Particular attention must be given to potential risks associated with private funds, for instance with regard to a potential loss of autonomy. However, both the ETH Board and the institutions are convinced that the existing internal regulation as well as incentives inherently set by the academic system sufficiently govern these matters within the ETH Domain. Over the last two decades or longer, the institutions of the ETH Domain have shown that they can engage in strong interactions with the private sector while at the same time maintaining true independence and sticking to their genuine mission as public institutions. To be able to benefit from the opportunities associated with this kind of collaboration with private actors, the ETH Board must therefore insist on maintaining, both internally and externally, the current culture of mutual trust and the corresponding innovation-friendly regulation of these matters (→ see part B.1 for details).

[6] As requested, the ETH Board will not continue to use the term "second-party funds" in the future. However, for the purposes of the present report, this terminology (i.e. the distinction between "second-party funds" describing competitively granted funds from governmental bodies, e.g. SNSF or ERC, and "third-party funds") was maintained, as the corresponding explanations are mainly retrospective and as it allows to link the challenges described in this report more easily to the previous evaluation reports on the ETH Domain.

A
The ETH Domain as a Driving Force for Innovation

A
The ETH Domain as a Driving Force for Innovation

Introduction

Under the performance mandate assigned to them by the Federal Council, the institutions of the ETH Domain play a key role in promoting Switzerland's innovative capacity. The entire ETH Domain is thoroughly committed to this role, as Switzerland's innovative capacity is paramount for the country as a whole. The ETH Domain institutions have continuously increased their KTT activities. Their ambition is to be a key player in strengthening and sustainably fostering Switzerland's innovative capacity. However, the institutions' ability to develop successful KTT activities depends on and derives immediately from the two additional main roles assigned to the ETH Domain under its performance mandate, namely teaching and research. These two roles, closely linked within the ETH Domain institutions, are therefore the most important components of their capacity to act as a driving force for innovation in Switzerland.

Teaching

As specified by the performance mandate, the institutions provide first-class teaching that is of the highest quality on an international comparison. In this way, knowledge and know-how are transferred into the economy as well as into public administration by the highly qualified students who leave the ETH Domain institutions every year ("KTT through people").

– In 2013, the institutions awarded 2,248 Bachelor's, 2,663 Master's and 993 Doctoral degrees. The detailed figures are shown in the following table:

Figure 1: Degrees awarded according to academic level

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Δ 2012/2013	in %
Bachelor's	**1**	**118**	**1,039**	**1,452**	**1,656**	**1,835**	**1,900**	**1,988**	**2,216**	**2,249**	**33**	**1,5**
ETH Zurich	1	118	381	838	1,086	1,283	4 527	1,283	1,447	1,447	0	0.0
EPFL			658	614	570	632	686,7	617	769	802	33	4.3
Master's/Diploma	**1,723**	**1,783**	**1,807**	**1,949**	**1,978**	**1,988**	**1,898**	**2,159**	**2,320**	**2,663**	**343**	**14.8**
ETH Zurich	1,167	1,144	1,203	1,309	1,306	1,317	1,270	1,506	1,650	1,847	197	11.9
EPFL	556	639	604	640	672	671	628	653	670	816	146	21.8
MAS/MBA*	**435**	**461**	**332**	**471**	**336**	**400**	**283**	**301**	**256**	**346**	**90**	**35.2**
ETH Zurich	237	233	226	213	213	239	174	203	184	228	44	23.9
EPFL	198	228	106	258	123	161	109	98	72	118	46	63.9
Doctorates	**719**	**774**	**861**	**852**	**832**	**962**	**986**	**1,027**	**1,095**	**993****	**-102**	**-9.3**
ETH Zurich	471	506	569	572	566	651	650	696	747	579**	−168	−22.5
EPFL	248	268	292	280	266	311	336	331	348	414	66	19.0

* Continuing education programmes MAS/MBA: Master of Advanced Studies/Master of Business Administration

** In the context of the revision of ETH Zurich doctoral regulations, the last doctoral graduation deadline of 2013 was postponed from December 2013 to January 2014. This explains the reduction in completed doctorates to 993 resp. 579; without this change, 1,168 resp. 754 doctoral students would have graduated in 2013.

Source: Annual Report of the ETH Board on the ETH Domain 2013, p 124.

- ETH Domain graduates are able to find qualified employment within a few months.[7] This coincides with the high demand in Swiss industry for specialists trained within the ETH Domain.
- Many of the top management positions in industry are occupied by alumni of ETH Zurich and EPFL or by people closely linked to one of the ETH Domain institutions.[8] For instance, in many of the SMI companies (incl. ABB, Sika, Lonza, SwissRe, Nestlé, Clariant, Swisscom, Roche and Novartis), one or more top executives or directors are associated with the ETH Domain.
- All ETH Domain institutions offer a wide range of practice-oriented programs in the field of academic continuing education. Thus, they provide valuable opportunities for life-long learning for practitioners in charge of promoting innovation within industry and society or responsible for the commercialization of scientific findings.

Research

As shown by academic indicators (e.g. rankings, bibliometric analyses[9]) and by the regular evaluations of individual institutions and departments, the ETH Domain institutions perform (fundamental) research on a world-class level. This capacity is essential for the ETH Domain's contribution to Switzerland's innovativeness, as fundamental research has always been the most powerful source of groundbreaking innovation and is therefore crucial for fostering the country's innovative capacity in the long term. This concerns at least three levels:

- Innovation can result directly from scientific findings and from the methods explored in research, which lead to applications inside and outside the scientific realm.
- Innovation results also from the process of designing, planning and implementing research endeavors. In particular, the realization of complex and/or large research infrastructures fosters innovation, as it requires that solutions be developed that can be successfully installed and operated.
- The transfer of staff and graduates, experienced in research, from the ETH Domain into the private and public sector acts an important driver for innovation, too.

Knowledge and Technology Transfer

In order to present a comprehensive picture of the ETH Domain institutions' contribution to innovation in Switzerland, it is important to adopt a broad concept of KTT. Most institutions produce knowledge about public goods. Such knowledge cannot be commercialized directly, but represents important background information for public and private actors in Switzerland. It thereby indirectly supports economic welfare and directly benefits society as a whole. The avalanche forecasts by WSL are a typical example: In mountainous regions, it is essential that avalanche hazard information reaches as many people as possible (both public and private

[7] See, for instance, the graduate survey of the Federal Statistical Office (FSO), http://www.bfs.admin.ch/bfs/portal/de/index/themen/15/06/data/blank/05.html#parsys_13494 (last accessed: November 24, 2014) or the brochure "MINT-Fachkräfte auf dem Arbeitsmarkt", Federal Statistical Office 2013 (http://www.bfs.admin.ch/bfs/portal/de/index/themen/15/22/publ.html?publicationID=5018; last accessed: November 24, 2014). See also the article "Ist die Volluniversität überholt?", Neue Zürcher Zeitung, September 11, 2013 (http://www.nzz.ch/aktuell/startseite/ist-die-volluniversitaet-ueberholt-1.18147876: last accessed: November 24, 2014).

[8] See, for instance, Umbach-Daniel, Anja (2008): Ingenieure im Top-Management der Schweizer Wirtschaft – Präsenz in Geschäftsleitungen und Verwaltungsräten. Karrieren und Karrierechancen, Rütter + Partner, im Auftrag von IngCH Engineers Shape our Future und dem ETH-Rat.

[9] See chapter E for the bibliometric analysis executed as part of the present intermediate evaluation.

actors). Therefore, selling this information on a market is not appropriate. While traditional KTT concepts may not include such aspects, it is suggested that the present evaluation should work with an extended view of KTT, including knowledge transfer to public and private actors about public goods as well as knowledge and technology transfer to companies.

In general terms, the ETH Domain institutions' involvement in the promotion of KTT in the higher education area can be summarized as follows:

- The institutions of the ETH Domain have been spearheading KTT at the Swiss universities and are acting as role models and as a reference for best practice, both on a national and an international level.
- Representatives of the ETH Domain institutions share their know-how and expertise in governmental bodies such as the "KTT-Support"[10] section of the Commission for Technology and Innovation (CTI) where, for instance, they are co-coaching National Thematic Networks.
- Representatives of the ETH Domain are also frequently founders, initiators or key academic partners in private initiatives such as the Venture Businessplan Competition, or are to be found in various committees and juries.
- Representatives of the ETH Domain institutions were key drivers and founders of swiTT, the Swiss Technology Transfer Association. SwiTT is the national platform for best practice exchange (through courses, training events, conferences etc.) and maintains the only national academic licensing opportunity list (swiTTlist)[11].
- Additionally, KTT representatives of the ETH Domain are frequently requested speakers, experts and consultants to universities and governments around the globe.

[10] See http://www.kti.admin.ch/netzwerke/00194/index.html?lang=de (last accessed: November 24, 2014).
[11] See http://www.switt.ch/www/adminall2/index.php?id=89825 (last accessed: November 24, 2014).

A.1
Contribution to Innovation Performance

"To what extent do the ETH Domain institutions contribute to innovation performance in Switzerland and to knowledge and technology transfer to Swiss industry and society? Where can improvements be made?"

A.1 Contribution to Innovation Performance

Assessment by the ETH Board

Assets

In Switzerland, the *ETH Domain offers a unique innovation ecosystem* covering all key stages, including education and science-based training of future specialists, high-level fundamental research, continuing education, implementation of technologies and discoveries in new applications, research collaborations with industry partners, and the creation of spin-offs.

As most groundbreaking innovations are rooted in discoveries generated through fundamental research and as they often involve interacting disciplines, the ETH Board is convinced that

- the core contribution of the ETH Domain institutions to innovation in Switzerland, but also worldwide, lies in their *excellent performance in terms of research and teaching;*
- this performance track record forms the *basis for any transfer of knowledge, know-how and innovation into the economy (in particular industry) and society* at large;
- the institutions of the ETH Domain effectively promote innovation by *internalizing and fostering a comprehensive entrepreneurial spirit in education and research;*
- the institutions of the ETH Domain have set up numerous instruments aimed at *linking research and innovation in an effective way.*

Challenges and Opportunities

Fundamental research is the core driver of innovation. Accordingly, innovation is generated through the advancement of knowledge and skills over longer time periods. Therefore, it is *inherently difficult to measure the direct impact* of many knowledge and technology transfer activities. This basic fact about the relationship between fundamental research and innovation *produces challenges on five levels:*

a) It makes it more difficult to assess and attribute the impact of contributions by individuals or particular institutions. Nevertheless, the ETH Board acknowledges the necessity to *further develop instruments for assessing the ETH Domain's contributions to innovation* in Switzerland, going beyond the instruments usually referred to.[12]

b) The ETH Board must stress the *overriding importance of the long-term orientation and the continuity of research and innovation* practiced within the ETH Domain. Currently, however, application-oriented research often seems to be more highly rated by the public for its more immediate results. As application- and short-term-oriented research mostly favor incremental innovation, long-term orientation and continuity of fundamental research must thus be defended as necessary prerequisites for higher education and research institutions to be able to contribute effectively to innovation – and specifically radical innovation – in the long run. This means that the institutions must be able to allocate funds to research areas or research projects with substantial failure risks and uncertain prospects of success: such "high-risk" research often yields the most groundbreaking innovative results.

"To what extent do the ETH Domain institutions contribute to innovation performance in Switzerland and to knowledge and technology transfer to Swiss industry and society? Where can improvements be made?"

[12] As shown below (see e.g. fig. 2), contributions to innovation are usually measured through the number of start-ups and spin-offs (and corresponding jobs) created, intellectual property rights (related to inventions [patents], software, etc.) and resulting licenses, as well as collaboration with industry or public actors.

c) Collaboration between the ETH Domain institutions and private companies can contribute to promoting Switzerland's innovative capacity. However, such collaboration is increasingly subject to critical scrutiny. The ETH Board must therefore *proactively communicate the rules and regulations governing such collaboration and the transparency that is achieved* in the ETH Domain. It must aim to make the public take a more positive view of collaboration with private companies.

d) The ETH Domain institutions must be able to retain their lead in the *future development of best practices in the field of KTT*.

e) Currently, the institutions of the ETH Domain experience a *funding gap between the Swiss National Science Foundation (SNSF) and the CTI*. Thus, some projects in the pre-competitive phase lack adequate funding from the funding agencies, although new funding instruments (such as precoR, which was launched on the initiative of Empa, among others) have been established.

A.1.1 Background

With regard to the classic KTT activities, all ETH Domain institutions have set up local tech transfer offices (TTO). Although they are organized differently according to the institutions' specific requirements, they all provide professional legal services regarding the setup of project-based collaborations with industrial partners. Furthermore, they drive the process of exploiting the institutions' intellectual property (technology assessment and protection, technology marketing, licensing and sale, support of spin-offs). They are well connected among each other and frequently meet to exchange information.

It is important to note that the ETH Domain institutions' overall KTT philosophy is that KTT is not profit oriented, but aims at making as many technologies as possible available for the Swiss economy and for society at large. Although commercial and financial aspects are considered, maximization of the socio-economic benefit, contributions to the strength of the economy in Switzerland and worldwide, and continuous improvement in the quality of life are far more important objectives. Therefore, the institutions have launched various initiatives to set up a seamless innovation value chain which allows for an efficient and effective KTT, both from the individual institutions and in collaboration with each other. Activities can be sub-divided in the fields of collaboration with industry (A.1.2), knowledge transfer to the public sector and in-house innovation (A.1.3), fostering of entrepreneurship and the foundation of spin-offs (A.1.4), and the exploitation of research results (A.1.5). In what follows, each of these fields is addressed separately. To give an overview of the activities and initiatives realized at the individual institutions, the most important examples have been assembled for each of these fields.

A.1.2 Collaboration with Industry

Collaboration with business, and in particular with industry, represents an important aspect of KTT at all institutions of the ETH Domain. On the level of the individual institutions, the activities and achievements described below are considered to be most relevant. Table 1a and 1b in Appendix 2 below present a success story from each institution, illustrating the particular aspects of collaboration with industry mentioned in this chapter.

As a general overview, the following figure shows that

- between 125 and 200 patents are filed every year thanks to the research performed within the ETH Domain institutions. The corresponding know-how is thus transferred into economy;
- the Research Institutes play an important role with regard to the licenses granted every year (in many cases spin-offs). These licenses contribute in large part to the commercialization of newly generated knowledge.

Figure 2: Knowledge and technology transfer activities of the ETH Domain institutions as reflected in patents (priority applications only) and licenses (including technology transfer agreements as well as newly founded companies (spin-offs)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Patents	**166**	**154**	**159**	**142**	**125**	**155**	**128**	**147**	**195**	**193**
ETH Zurich	85	77	84	79	64	78	63	72	87	103
EPFL	43	44	36	36	40	44	47	52	75	66
Research institutes	38	33	39	27	21	33	18	23	33	24
Licences	**111**	**117**	**152**	**218**	**178**	**176**	**178**	**194**	**230**	**223**
ETH Zurich	25	23	24	42	48	37	39	45	35	38
EPFL	42	46	56	64	29	47	45	50	31	41
Research institutes	44	48	72	112	101	92	94	99	164	144
Spin-offs	**25**	**19**	**28**	**33**	**46**	**45**	**38**	**40**	**38**	**43**
ETH Zurich	12	9	16	21	23	24	20	22	22	24
EPFL	8	5	8	12	18	20	14	15	12	12
Research institutes	5	5	4	0	5	1	4	3	4	7

Source: Annual Report 2013, p. 125.

- In addition, representatives of the ETH Domain frequently participate in bodies such as advisory boards, boards of directors, etc. both in the private and in the public sector, which represents an important aspect of networking and know-how transfer.

On the level of their additional priorities and activities deployed in the field of KTT, the institutions highlight the following aspects and non-exhaustive examples:

ETH Zurich

ETH Zurich has established a seamless line of activities and platforms to interact with industry on a frequent basis, to exchange views and ideas, to learn about latest trends and to eventually find common interests to enter into seed projects, extensive research collaborations or strategic partnerships. Central entities were put in place to help to make the wealth of know-how and technologies produced within ETH Zurich available to its industrial partners in an efficient and effective way. In particular, this role is assumed by ETH transfer, the TTO of ETH Zurich, the Industry Relations Group as the main entrance for industry, and the ETH Zurich Foundation. They encourage exchange with individual companies and industry associations, and perform or provide support in the activities mentioned below.

- Every year, ETH Zurich invites the Swiss Industry to the ETH Industry Day to present and discuss research fields and newest technologies from the institution's 16 departments. More than 300 persons attend this half-day event on campus, structured around short presentations across ETH Zurich's research activities, discussion panels, and informal meetings.
- The university maintains strategic partnerships with industry in a large range of areas, including world food supply, risk management, sustainable construction, integrative risk research, information security, electrical energy or manufacturing across scales. Such partnerships quicken the process of establishing strategic research areas through endowed

professorships and interdisciplinary research projects and allow for open discussion in common Partnership Councils on new visions and approaches.

- ETH Zurich also contributes to and maintains strong ties with the "younger" players of the industry, i.e. its spin-offs. The institution has set up a community network with its more than 350 spin-offs (of which more than 110 founded in the last 5 years), to meet and exchange experiences, to help the younger generation on their journey and keep a close contact with ETH Zurich.
- In the last two years (2012-2013), ETH Zurich has entered more than 1,400 new formal research agreements with third parties – whereof more than 500 with Swiss companies – with a total volume of more than 300 MCHF.
- In the same time, the tech transfer office has handled more than 4,400 new contracts between ETH Zurich and third parties.
- Interactions between ETH researchers and industry have increased by 40 % over the past five years, or nearly quadrupled over the past ten years.
- As ETH Zurich has an international outreach, the institution maintains collaborations with companies across the planet, making sure that it has access to latest developments and needs in industry from around the globe.

While intensifying the interaction with industry, ETH Zurich has set up clear and transparent regulations and processes to ensure independence and compliance. The institution and its faculty make sure that projects are scientifically or technically relevant, the results can be freely used afterwards for further research and educational purposes, publication rights are granted to ETH Zurich, a reasonable agreement with regard to ownership of IP and rights for commercial use can be found (including dequate financial compensation) and the freedom with regard to future collaborations with other third parties is guaranteed.

Another prominent example of a collaborative partnership between ETH Zurich and industry is the Binnig and Rohrer Nanotechnology Center (BRNC) in Rüschlikon. Through this joint investment with IBM, among the biggest public-private partnerships of their kind in Switzerland, a clean-room laboratory was built, enabling premier research at an international level.

As an example of successful collaboration with industry, ETH Zurich presents the "Lablet" concept in Table 1a, Appendix 2, p. 165.

EPFL

Over the past five years (2009-2013), EPFL has collaborated primarily with Swiss companies, many of which are small and medium enterprises (SME). For instance,

- 70 % of the contracts dealt with by the TTO of EPFL had a Swiss company as a principal partner (100 % = 817 contracts);
- 74 % of the monetary value represented by these contracts is raised in contracts with a Swiss company as a principal partner (100 % = 162 MCHF);
- 41 % of these contracts with Swiss companies are concluded with SMEs and start-ups with fewer than 250 employees.

To foster collaboration with partners from industry, EPFL offers a variety of collaboration agreements, which range from research-specific contracts to general frameworks, up to the association of Research and Development (R&D) teams on the EPFL campus. In order to facilitate the conclusion of cooperation agreements with industrial partners, standard agreements are

[13] See http://tto.epfl.ch/collaboration_with_the_economy (last accessed: November 24, 2014).

published online (with summaries for non-legal persons).[13] Representatives of EPFL, in particular its Vice-president for Innovation and Technology Transfer (VIPV), proactively meet with over sixty national and international companies per year in order to identify their needs and the potential for collaboration.

With regard to the licenses granted by EPFL to commercial companies between 2009 and 2013, the involvement of Swiss companies was as follows:

- 73 % of the licenses were attributed to Swiss companies (100 % = 176);
- 80 % of the licenses attributed to Swiss companies were attributed to SMEs or start-ups with fewer than 250 employees.

As an example of successful collaboration with industry, EPFL presents its "Innovation Park" in Table 1a, Appendix 2, p. 165.

PSI

Thanks to its highly sought-after role as a user lab facilitator, the PSI engages in a particularly intensive collaboration with industry.[14] In order to support and promote such collaboration, the PSI TTO acts as link between a potentially interested company with a particular technical or scientific problem and the corresponding experts at the PSI. In the context of the creation and implementation of the PARK innovAARE concept[15], the TTO's strategic focus was shifted towards an internal business development unit supporting the settlement of industrial partners in the immediate vicinity of the PSI. Compared to former collaborations, this ongoing process generates a new level of linkage between the PSI and industry, particularly if both partners share common interests in selected innovation focal points and if the activities are highly complementary.

The following points summarize important aspects of cooperation between industrial partners and the PSI:

- PSI has a proven record in attracting a large amount of direct industry use of its large-scale research facilities (>10 % vs. an international average of 5-7 % in the case of synchrotrons).[16]
- Cooperation takes the form of licensing and technology transfer, R&D services, research contracts, or joint research cooperation projects.
- A large number of highly trained scientific and technical staff leave the PSI for Swiss industry every year.
- The PSI strives to make new findings from in-house development of technologies or measurement methods at the large-scale research facilities accessible to industry, thereby strengthening the competitiveness of Swiss industrial companies. About 40 patents are filed every year at the PSI with typically 10-15 initial applications.

The PSI's collaboration with industry also enables the kind of innovation that derives from the very fact that research infrastructures need to be designed, developed and realized:

- During the development phase of new research infrastructures, technological innovations with considerable market potential are created.
- A typical example of this kind of cooperation and technology transfer is the development and production of key components for the PSI's next large-scale research facility, SwissFEL, by partnerships with companies in Switzerland such as TEL Mechatronics (Trübbach), MDC Max Daetwyler AG (Bleienbach), and Ampegon (Turgi).

[14] Examples of industry collaborations can be found under www.psi.ch/industry/companies (last accessed: November 24, 2014).
[15] See chapter A.3 below.
[16] According to the ERID-Watch project, project number 043004, final prospective report, 2009 (see http://cordis.europa.eu/documents/documentlibrary/125670151EN6.pdf; last accessed: November 24, 2014).

- Based on in-house PSI developments, the industrial partner takes over responsibility for manufacturing, assembly and qualification of the respective accelerator structures.
- This cooperation enables the company to expand its skills in the field of ultra-precision machining and metrology, to access and establish itself in highly complex markets and to present its competencies to other research institutions as potential future partners.

As an example of successful collaboration with industry, the PSI presents the start-up story of "Ampegon" in Table 1b, Appendix 2, p. 166.

Empa

Collaboration with industry has always been a high priority for Empa. This is demonstrated by the following aspects:

- On average, more than 100 new joint research projects are launched every year.
- Besides the intensive exchange with industrial partners within research projects, the development of joint platforms is a key focus for Empa: With NEST, for instance, Empa is developing a research and technology platform for future building technologies supported by the entire ETH Domain. The project involves leading partners from industry and several national and international universities. Construction of this multi-million project is set to start in late 2014.
- Switzerland is one of the world's leading players in coating technology, with 80 % of hard coatings being produced by Swiss companies. Empa is therefore teaming up with partners from industry and academia to set up the Coating Competence Center (CCC) on its campus in Dübendorf.
- With about 100 events and seminars annually, the Empa Academy at Dübendorf provides an appealing platform for knowledge dissemination and networking; nearly two thirds of the 5,000-plus attendees come from industry.

As an example of successful collaboration with industry, Empa presents the invention of "Clothing that doesn't absorb odor" in Table 1b, Appendix 2, p. 166.

WSL and Eawag: Focus on public goods

Industry collaboration is at a lower level at WSL and Eawag, as these two institutions mainly deal with public goods. By its very nature, this provides fewer opportunities for collaborating closely with the private sector.

Many collaboration activities of the ETH Domain institutions, in particular WSL and Eawag, involve partners situated between industry and the public sector. In the case of Eawag, for example, collaboration with operators of wastewater treatment plants, including the related associations and planners involved, represents such a type of interaction at the interface between industry and public authorities. It entails innovation with direct practical relevance, although such innovation has limited potential for commercialization.

As the example of Eawag shows, foundations which, in a particular field, fund the development of new inventions from research to practical application are another important type of private-sector collaboration partners.

As successful examples of collaboration with industry on public goods and involving a foundation, WSL and Eawag, respectively, present the "NESSy" project and the "toilet for developing countries" case in Table 1b, Appendix 2, p. 166.

Competence Centers of the ETH Domain
Some of the competence centers of the ETH Domain (e.g. CCMX, CCEM) have the explicit mandate to create closer connections between the ETH Domain and the needs of Swiss industry. This aspect will also be important for the recently established Swiss Competence Centers for Energy Research (SCCER; these competence centers are not part of the ETH Domain, but benefit from a high involvement of ETH Domain institutions). Involving different research institutions and industrial partners, the competence centers should improve collaboration of academia with industry. The funding schemes support (amongst others) pre-competitive research projects with a special emphasis on potential technology transfer to industry. Different forms of networking events (e.g. CCMX Technology Aperitifs, Novatlantis forums) are conducted to create contacts between stakeholders and to stimulate potential partnerships. One of the main challenges of the competence centers is to establish longer-term research platforms rather than individual projects of fixed duration, especially since start-up financing by the ETH Board will be phased out by 2016.

A.1.3 Knowledge Transfer to the Public Sector and In-house Innovation

Due to their particular role and their specific tasks, the institutions of the ETH Domain also contribute significantly to knowledge transfer to the public sector (federal, cantonal and local authorities) or to (professional) associations, which can again stimulate innovation, for instance with regard to practical problems in environmental management. In these cases, innovation often comes directly from the projects in which the ETH Domain institutions are involved and are thus examples of "in-house innovation". Given their specific roles, some of the Research Institutes contribute mostly in this way to innovation in Switzerland. They are important partners for the Federal Offices (e.g. in energy, environment, transportation, public health, etc.), and also for the cantons. The experienced research staff of the ETH Domain's Research Institutes also act as consistent partners for practitioners and stakeholders, providing independent expert opinions.

Examples from WSL and Eawag
In the areas of terrestrial and aquatic environmental research, WSL and Eawag are two of the most important research institutions in Switzerland. Both WSL and Eawag conduct knowledge transfer activities with a primary focus on public actors. WSL and Eawag's portfolios in applied research are partly developed in cooperation with federal and cantonal authorities. Cooperation with industry and practice (e.g., municipal utilities) allows WSL and Eawag to develop and promote innovative environmental technologies.

Examples from WSL include:

- A handbook for the preparation of ski slopes;
- in-house innovation of avalanche forecast procedures and their successful application in Switzerland and abroad;
- the White Risk e-learning tool to disseminate advanced avalanche-specific knowledge among all kinds of winter tourists;
- "Merkblätter für die Praxis" (practical factsheets, e.g. about invasive species or minimizing damage to forest soils with modern harvesting machines);
- in-house improvement of forest inventory methods that are directly implemented in the national forest inventory used by private and public actors;
- joint projects with the public sector to improve knowledge about the forest/climate change interaction.

The following are examples of Eawag's key practice-oriented activities:

- A series of reports on micropollutants and assessments of wastewater quality issued by the Swiss Center for Applied Ecotoxicology (a joint activity of Eawag and EPFL);
- a method for rapid detection of microbes in drinking water developed by Eawag researchers in a project jointly funded by Eawag and the Federal Office of Public Health (included in the Swiss Food Compendium in 2012);
- two platforms for stakeholder engagement and outreach hosted by Eawag, jointly funded by agencies including federal and cantonal offices, professional societies, municipal utilities, private foundations, and public interest groups: the fisheries advisory service FIBER[17] provides information and advice through a variety of formats, including a website, newsletter and public presentations; the discussion platform Water Agenda 21[18] provides a venue for cooperation among various actors in the water sector and engages in projects to support decision-making in areas such as hydropower and water resources management.

In addition, both institutions are strongly involved in courses offering continuing education for practitioners. For instance, Eawag's program of practice-oriented courses (PEAK) includes courses offered by the Ecotox Center or offered in cooperation with Swiss professional associations for drinking water (SVGW) and wastewater and water protection (VSA).

Specific institutes

Further examples from other ETH Domain institutions for knowledge transfer to the public sector in which in-house innovation comes into play include:

- KOF Swiss Economic Institute of ETH Zurich is one of Switzerland's leading economic think tanks. KOF acts as a mediator between a broader public (government, society) and the research community and as a leading platform for economists, especially within Switzerland. Another major function of the KOF is scientific research for dissemination in academic and related professional circles via publications and participation in international meetings and conferences.
- The Swiss Seismological Service (Schweizerischer Erdbebendienst SED) at ETH Zurich is the federal agency responsible for monitoring earthquakes in Switzerland and its neighboring countries and for assessing seismic hazards in Switzerland. When an earthquake occurs, the SED informs the public, authorities, and the media about the earthquake's location, magnitude, and possible consequences. The activities of the SED are integrated in the federal program for earthquake risk reduction.
- The NABEL monitoring network (Nationales Beobachtungsnetz für Luftfremdstoffe) is operated by Empa, mandated by the Federal Office for the Environment (FOEN), which is responsible for the enforcement of the Ordinance on Air Pollution Control (OAPC). The NABEL database enables FOEN to observe trends and to evaluate the success of air pollution measures on a yearly basis. State-of-the-art analytical methods for newly discovered, potentially harmful trace gases are being employed and developed by Empa experts. These include a quantum cascade laser-based method for the isotope-specific detection of various species of carbon dioxide (CO_2) as well as other pollutants. Interestingly, the very same technology can also be used for industrial (leak detection in aerosol cans) and medical purposes (early detection of stomach cancer).
- The PSI Bildungszentrum offers a broad selection of education and training courses, for instance courses on radiation protection for professionals from medicine, industry and public authorities, as well as training in the operation of nuclear reactors for staff of the Swiss nuclear power plants.

[17] See www.fischereiberatung.ch (last accessed: November 24, 2014).
[18] See www.wa21.ch (last accessed: November 24, 2014).

- Representatives of all ETH Domain institutions are frequently active as members of expert groups at the cantonal or federal level.
- The ETH Domain institutions contribute to the development of codes of practice, for instance in the construction area (SIA codes of practice, etc.)

A.1.4 Fostering of Entrepreneurship and the Foundation of Spin-offs

The institutions of the ETH Domain have set up various programs to raise the awareness of their faculty and employees of the socio-economic value of research results and to stimulate the generation of inventions and business ideas. Due to the novel nature of technologies resulting from fundamental research, the successful transfer of such technologies to existing industrial players has proven to be particularly challenging.

Therefore, spin-offs represent an increasingly important vehicle for fostering innovation. Such spin-off companies are founded and developed by scientific talents with an entrepreneurial mindset. In order to stimulate the creation of spin-offs and to support their entrepreneurs from the very beginning, the ETH Domain institutions offer a comprehensive set of instruments to identify, foster, promote and mature the entrepreneurial aptitudes of their students and collaborators. These instruments include

- stimulation programs (e.g. the Spark Award for the best invention of the year at ETH Zurich);
- proof-of-concept funds (e.g. Innogrants at EPFL, Pioneer Fellowship at ETH Zurich, ENABLE program at EPFL);
- dedicated office and lab space (e.g. ieLabs at ETH Zurich, La Forge at EPFL, glaTec at Empa); and
- community building (e.g. at ETH Zurich, through the ETH Entrepreneurship Club, the ETH Founders Community, Alumni Homecoming Dinners, etc.).

In terms of examples, Table 2 (Appendix 2) presents the most important instruments that have been implemented by ETH Domain institutions.

The success of the spin-offs from the ETH Domain institutions can be measured on various levels:

- In a recent study regarding spin-offs of ETH Zurich, it has been shown that 122 responding companies have generated 2,500 new jobs and have aggregate annual sales of close to 600 MCHF.[19]
- EPFL start-ups have been able to raise more than 800 MCHF in venture capital in recent years. While the amount has been higher than 100 MCHF in 2012 and 2013, 2014 has been an all-time record year with more than CHF 220 MCHF, i.e. twice the sum of the previous year, having been invested in EPFL start-ups.[20] EPFL spin-offs have attracted prestigious US funds both in IT (TypeSafe, Kandou) and in Life Sciences (Anokion, Quartet, Mitokyne, Bicycle).
- In general, ETH Domain spin-offs attract more than 200 MCHF in funding every year, both from corporate and institutional venture capital funds and, not infrequently, as FDI (e.g. the Tata Group's investment in Flisom). Even US venture capital funds regularly invest in the ETH Domain spin-offs.

[19] These are conservative estimates: for confidentiality reasons, many companies did not disclose their results.
[20] See, for instance, http://actu.epfl.ch/news/record-investment-in-epfl-start-ups-2/.

- Over a rolling five-year period, the ETH Domain spin-offs have close to a 90 % survival rate, which is far higher than the average survival rate of spin-offs.
- At an early stage, these spin-offs are frequently awarded prizes, feature in lists of the best start-up companies, and are portrayed in news media such as the NZZ, Red Herring, The European Wall Street Journal, CNN, etc. For instance, EPFL had three winners (LESS, Samantree & Flyability) out of five at the Zurich-based Venture competition in 2014. Also, the ETH Domain companies represent more than 50 % of the "venture kick" funding with EPFL (4 MCHF) and ETH Zurich (3.5 MCHF).
- The spin-offs are increasingly attracting the attention of big corporates as acquisition targets. In August 2014, the ETH Zurich spin-off Covagen, for example, was acquired by Cilag International GmbH (Janssen/Johnson&Johnson) for more than 200 MCHF. Other recent examples include, Kooaba (Qualcomm, Jan 2014), Time-Bandwidth Products (JDSU, Dec. '13/Jan. '14), Phocone (Camlin Group, Dec.'13/Mar.'14) or Procedural (ESRI, 2011) for ETH Zurich and Jillion (by DailyMotion) and Aimago (by Noadaq) and Sensima (Monolithic Power) for EPFL.
- The acquisition of ETH Domain spin-offs may also be seen by non-European corporates as a means of entering the European market. For such companies, this additionally makes Switzerland an attractive landing spot for setting up a European head office.
- Not all the companies are acquired and, although they may grow slowly in some cases, they reach maturity over time. Nexthink is such an example: it has more than 150 employees 10 years after its foundation. Similarly, Sensirion has grown, since its foundation in 1998, to as many as almost 600 employees today. Some companies even make it to the stock exchange or go IPO (e.g. mBlocs).
- Whether acquired or independent, spin-offs from the ETH Domain usually keep Switzerland as their home base, generating jobs and revenues, which in turn generate tax income as well.
- The Research Institutes also have a proven track record of successfully created spin-off companies. For instance, the companies SwissNeutronics and Dectris have developed from initiatives at PSI into world market leaders in neutron optical devices and X-ray detectors.

In conclusion, the ETH Domain spin-offs have started to have a noticeable impact on the Swiss economy and are an important vehicle for making novel technologies available to society. Widespread spin-off support at the ETH Domain institutions has steadily increased awareness among students of the economic value of their research and created an entrepreneurial mindset. This represents an important contribution to innovation in Switzerland.

A.1.5 Exploitation of Research Results

Exploiting research findings for the creation of economic value is another mission of the ETH Domain institutions. It contributes directly to enhancing Switzerland's innovative capacity.

- The ETH Domain institutions produce a wealth of know-how, software and technologies in almost all fields of engineering, natural science and Life Sciences, as well as in the MedTech domain.
- The TTOs have set up efficient and effective processes and networks to assess, protect and market such intellectual property (IP).
- As shown above, they handle several hundred invention disclosures and file almost 200 new patents every year[21], tapping into a pool of several dozen highly specialized external national and international patent attorneys to ensure cost efficiency and maximum protection.
- They maintain professional technology management and CRM systems and use various channels to market their IP, including direct mailings (TechAlert) and web postings of fact sheets, presentations on national and international fairs, technology meetings, etc.

Although the IP statistics as such look impressive, the most important aspect as outlined above is that the know-how and the technologies generated within the ETH Domain find their way to industrial application. From the perspective of the ETH Domain, it is therefore of great importance that the institutions' scientific work should manifest itself in an impressive wealth of products on the market, both in number and in breadth of application. According to the above-mentioned broad understanding of KTT, however, it is equally important for the impact of the ETH Domain institutions' scientific work to be reflected in innovation and resulting improvements in the public sector, e.g. by increasing the reliability of avalanche prediction. In such fields, the institutions deal with topics relating to public goods, in which there is no market for intellectual property to be commercialized. When measuring the impact and the success of the ETH Domain in exploiting its research results, such areas must also be taken into account.

[21] See figure 2 for numbers.

A.2
Freedom and Incentives for Curiosity-Driven Research

"Do the ETH Domain institutions have sufficient freedom and incentives to conduct curiosity-driven research, so that effective bases for future innovation can be laid? Which instruments allow curiosity-driven research to take place, and which instruments are still required?"

A.2 Freedom and Incentives for Curiosity-Driven Research

Assessment by the ETH Board

Assets

Long-term oriented fundamental research – curiosity- or discovery-driven by its very nature – is of crucial importance for promoting and fostering Switzerland's innovative capacity. This kind of research is most effectively promoted through the *allocation of adequate, stable and freely disposable basic funding*. The ETH Board emphasizes that

- the ETH Domain institutions generally *take a positive view of* their liberty to pursue curiosity-driven research;
- for realizing their research strategies, it is of crucial importance that they can *autonomously allocate their global budgets*;
- the *overall financing system* (basic funding allocated by the owner, second-party funding[22] by the SNSF or EU, third-party funding) is well balanced;
- the institutions have *set up adequate internal instruments* that generate incentives for focusing on prospective research topics and engaging in long-term oriented and "high-risk" projects. Examples include internal competitive research grants, as well as structures and incentives for research collaborations within institutions and between them.

Challenges and Opportunities

Despite this generally positive assessment, the ETH Board concludes that *three current challenges* must be addressed:

a) An increasing *need for coordination among institutions* can jeopardize quick and flexible implementation of innovative ideas. Researchers must be enabled to collaborate with the best possible partners worldwide. Furthermore, coordination absorbs resources. It should therefore be limited to cases in which its added value exceeds the costs.

b) Autonomy to engage in curiosity-driven research means that *programmatic research must not be imposed on the institutions* to the extent that their capacity to develop their freely chosen and novel research priorities is impaired.

c) *Incomplete coverage of overhead costs* associated with project and program funds from the SNSF *and the financial matching required by other funding partners* remains problematic for the institutions, as it forces them to attribute funds from other sources (typically basic funding) to such projects. Raising the overhead rates in Swiss competitive research funding would considerably expand the financial possibilities of the institutions when acquiring competitively funded research projects that typically are inspired by innovative ideas. Such an increase, however, should not compete with basic funding and impede a potential increase in these funds.

"Do the ETH Domain institutions have sufficient freedom and incentives to conduct curiosity-driven research, so that effective bases for future innovation can be laid? Which instruments allow curiosity-driven research to take place, and which instruments are still required?"

[22] See above, footnote 6.

A.2.1 Funding for Curiosity-Driven Research at the ETH Domain Institutions

As groundbreaking discoveries – which lead to innovation – are difficult to project and predict, it is vital for all research institutions to allow their researchers to freely define their research topics. As will be outlined in more detail below[23], program-oriented research, representing a top-down approach to setting research priorities, can be a reasonable means to push forward particular areas in which an urgent need for new solutions exists. However, such top-down approaches can impair innovation if they absorb resources that would otherwise enable curiosity-driven fundamental research, the key driver for groundbreaking innovation in the long term. Therefore, if science policy intends to promote innovation through the mandate attributed to the ETH Domain institutions, it is decisive that the three following factors are supported:

- a far-reaching autonomy of the institutions, i.e. the freedom to choose their research topics independently of the question of whether an immediate impact can be realized – for instance through publications;
- stable and adequate basic funding through global budgets;
- an open-minded attitude supportive of fundamental research that is not only curiosity-driven, but also long-term oriented.

In order to promote curiosity-driven research, the ETH Domain institutions have set up particular internal funding instruments and practices which can be described as follows:

ETH Zurich

- Fundamental elements are stable basic funding as well as generous start-up packages attributed to the chairs; besides the teaching activities, these also cover the setting-up of entirely new research ideas which are not yet sufficiently elaborated for application in competitive funding schemes.
- Internal competitive programs for the promotion of research set incentives to engage in curiosity-driven research (such as the ETH Zurich Research Grants, ETH Zurich Postdoctoral Fellowship Program and ETH Zurich Seed Projects).
- Through its Scientific Equipment Program, ETH Zurich allocates, on a competitive basis, funds for research infrastructures enabling curiosity-driven research. In addition ETH Zurich provides an increasing number of state-of-the-art technology platforms which are open to all ETH researchers.
- ETH Zurich provides several programs to develop and train young academics which offer them scientific freedom and responsibility at an early stage in their career (e.g. assistant professorships with and without tenure track, ETH Zurich Fellowship Program, Society in Science – The Branco Weiss Fellowship). These programs are important tools for fostering curiosity-driven research.

EPFL

- The EPFL strategy is based on giving the EPFL professors adequate equipment either for their own lab or within user friendly platforms so that they can successfully compete for external funding.
- A generous start-up package and basic funding are provided to give each lab sufficient research freedom.

[23] See chapter B.1.

– One engine of curiosity-driven research is EPFL's tenure track program, which gives researchers early individual responsibility (and the necessary means) to pursue their ideas.

Research Institutes

– The PSI has initiated a cross-departmental initiative supporting basic research projects that could not be conducted by a single research department only. In general, the majority of these multidisciplinary basic-research projects performed at PSI are curiosity-driven.

– At WSL, innovative research projects in their early stages that cannot be supported through other channels are selected for support via an internal Open Call once or twice every year.

– Empa regularly launches internal Research Calls in pre-defined areas. In 2013 a total of 11 projects were funded in the areas of functional surfaces, metamaterials, and multiscale modelling.

– At Eawag, a key instrument in this regard is the Discretionary Funding program for internal projects. Priority is given to projects that demonstrate Eawag's capacity for transdisciplinary research, bring its capacities together in a new way, or are directed toward emerging or novel problems.

A.2.2 Funding Agencies

A survey conducted in 2013 by the Nordic Institute for Studies in Innovation, Research and Education (NIFU) on behalf of SNSF has addressed the views and experiences of researchers in Switzerland concerning research funding.[24] The report provides the following insight:

– In general, researchers in the ETH Domain are more satisfied than researchers at other institutions, and give higher rating on the subject of internal funding, services and infrastructure.

– Benchmarking against similar data from other funding agencies shows that SNSF funding is highly rated when it comes to offering opportunities for unique/original research.

– However, the results are less positive for SNSF funding schemes addressing high-risk ("blue sky") topics, flexible use of funds and support for new projects that do not require preliminary research.

– The survey has also indicated that a substantial proportion of the researchers find that none of their funding alternatives is adequate for facilitating interdisciplinary research.

[24] See Swiss Research Funding. Researcher Survey for the Swiss National Science Foundation (SNSF), NIFU Report 5/2014, http://www.snf.ch/en/researchinFocus/newsroom/Pages/news-140520-researcher-survey.aspx (last accessed: November 24, 2014).

A.3
Contribution to the Creation of the Swiss Innovation Park

"Do the ETH Domain institutions pursue suitable strategies to contribute in the best possible manner to the successful creation of an innovation park? Where can improvements be made?"

A.3 Contribution to the Creation of the Swiss Innovation Park

Assessment by the ETH Board

Assets

Given the politically determined distribution of responsibilities between the federal and the cantonal levels, the *ETH Board has so far refrained from taking up an independent role* in the process of creating a Swiss Innovation Park.

However, it *follows and supports closely* the activities of the ETH Domain institutions in this regard. The ETH Board

- has acknowledged with satisfaction that the ETH Domain institutions' *role has always been defined as key* for the entire project;
- is convinced that the ETH Domain institutions have contributed, so far, in a *productive manner* to the ongoing establishment of the Innovation Park, having respected the distribution of responsibilities among the political authorities involved;
- was *instrumental in promoting and fully endorses the concept with two regional hubs*, ensuring close involvement of ETH Zurich and Empa in Dübendorf, and EPFL in Lausanne;
- is pleased by the successful candidature of the Canton Aargau to establish an *additional network location* in the immediate vicinity of the PSI.

Challenges and Opportunities

Given the Swiss Innovation Park's progress to date and taking account of its institutional role, the ETH Board currently identifies *two main challenges*:

a) The question of whether the structure chosen for the project's implementation at the various sites can satisfy the expectations of politics and economy must be carefully monitored by all actors involved, in order to *fully seize the opportunities* associated with the Swiss Innovation Park project.

b) All actors, including the ETH Board, must join forces to ensure that the necessary *decisions for the further development of the sites* designated as Innovation Park locations are taken by the competent authorities within a suitable timeframe.

"Do the ETH Domain institutions pursue suitable strategies to contribute in the best possible manner to the successful creation of an innovation park? Where can improvements be made?"

A.3.1 Background

The Swiss Innovation Park is conceived as a nationwide network around two main hubs. The aim is to foster Switzerland's innovative capacity and to make more effective use of the existing regional expertise, initiatives and particular economic strengths for innovation in Switzerland. The idea of a Swiss Innovation Park was launched in 2007 as a long-term project with a time horizon of at least 30 to 40 years.

The organization and further promotion of the Swiss Innovation Park has been placed under the authority of the cantons, where the Conference of the Cantonal Ministers of Economics (CCME) has been mandated by the Federal Department for Economic Affairs, Education and Research to elaborate a more detailed concept for its implementation.[25] The Conference decided in June 2013 that the Swiss Innovation Park should be a nationwide network of competencies with two centers of excellence ("hubs") built up around ETH Zurich and EPFL. The two hubs are to be complemented by network partners ("Netzwerkstandorte"), which will be specialized and focused on particular professional areas.

In conceptualizing the Swiss Innovation Park, the CCME closely collaborates with the "Swiss Innovation Park" association.[26] The purpose of this association, founded in March 2012, is to set up the Swiss Innovation Park as prescribed by law. It will secure the nationwide framework for the project and coordinate the regional initiatives. Several cantons (represented through their Ministers for Economic Affairs), institutions of the ETH Domain, Universities of Applied Sciences, and local authorities are affiliated to the association. With representatives from ETH Zurich, EPFL and Empa, the ETH Domain is prominently represented on the association's board.

In November 2013, the CCME launched the selection procedure for the network partners. The cantons were invited to submit concepts for the establishment of such networks based on specific requirements, such as

- the need for the network to be self-supporting;
- the excellence of participating partner institutions (companies, higher education and research institutions);
- the existence of sufficient resources in terms of financial commitment and available space;
- the necessity to prove that regional planning allows for the establishment of the projected innovation area.

By the end of March 2014, the cantons had submitted eight projects for network partner locations, each of which aimed to become a network location within the Swiss Innovation Park in addition to the two Hubs (around ETH Zurich and EPFL) already designated. Six of the eight projects have acquired partners from the ETH Domain (entire institutions or particular departments) through formal cooperation agreements or letters of intent. In the Canton of Aargau, the PSI is intended to serve as the location around which the entire network location will be developed.

The CCME decided at the end of June 2014 on the further implementation of the Swiss Innovation Park. According to the CCME, the Swiss Innovation Park should initially comprise the two Hub locations plus two additional network locations selected for the quality of their submission and the excellence they contribute to the entire Innovation Park network. These two network location projects are "PARK innovAARE", developed by the Canton of Aargau, and the project submitted by the north-western cantons (Basel-Stadt, Basel-Landschaft and Jura), which will be located in Basel. While the PSI plays a central role within PARK innovAARE, both ETH Zurich and the PSI have formally declared their interest in supporting the Basel project, too. The CCME decision now takes the form of a recommendation to the Federal Department

[25] On the level of the Confederation, the law for the promotion of research and innovation (Loi sur l'encouragement de la recherche et de l'innovation, LERI, SR 420.1 [no English translation available]), which was adopted by the national parliament in 2013 and came into effect on January 1, 2014, provides the legal basis for the support of the Swiss Innovation Park by the federal government. This support, however, must not be financial (except for loans).

[26] See www.swissinnovationpark.ch (last accessed: November 24, 2014).

of Economic Affairs, Education and Research, which will be in charge of formulating a Message addressed to Parliament on the concept of the Innovation Park to be implemented as of 2016.[27] According to the CCME directorate, the six other projects that were submitted in the first round will stay in the running to become a part of the Swiss Innovation Park, but have to be processed further.

A.3.2 Involvement of the ETH Domain

Although their role has always been defined as subsidiary, the ETH Domain institutions have been heavily involved in the creation of the Swiss Innovation Park right from the beginning. From the outset, part of the idea has been to develop at least one location on the site of the former military airfield at Dübendorf. So both Empa and Eawag, whose main campus is very close to the Dübendorf airfield, as well as ETH Zurich already played a major role in the early concepts. Similarly, EPFL played a leading role at an early stage in the development of the Innovation Park in Western Switzerland. In more detail, the main contributions are as follows:

ETH Zurich

- In view of the Zurich hub, planned at the Dübendorf airfield, the foundations and the project organization are being further developed with participation of ETH Zurich. Studies regarding urban development provide the basis for a cantonal Gestaltungsplan currently being elaborated by the competent authorities. In September 2014, the Federal Council decided that the Dübendorf airfield should in the future be used in three ways simultaneously: in addition to the Innovation Park, military aviation (helicopters) as well as civil (business) aviation should continue to use the site as an airfield. The decision gave rise to widespread political opposition, which raises considerable uncertainties about the near future of the project as well as the timeframe for realizing next steps. Even so, the formal establishment of the Zurich hub is planned for 2016.
- In addition, ETH Zurich is participating in the Basel network location with its Department of Biosystems Science and Engineering (D-BSSE).

EPFL

- EPFL and five cantons of Western Switzerland (Vaud, Genève, Neuchâtel, Valais, and Fribourg) have decided to join forces in order to develop the "PNI Hub EPFL"[28]. This concept is being developed in conjunction with EPFL's antennae strategy and the corresponding specific academic domains.[29] The following dedicated PNI sites will be devoted to interactions with industry: EPFL Innovation Park and Biopôle in Lausanne; Campus Biotech in Geneva: neuro-engineering (Wyss Center), Human Brain Project; Microcity in Neuchâtel: microtechnology, advanced manufacturing; Energypolis in Sion: energy, green chemistry; Blue Factory in Fribourg: sustainable architecture, smart building. EPFL has full academic responsibility for these hubs. One additional objective is to extend interactions between local academic partners (universities, HES, Research Institutes) as well as with industry.
- Within this delocalized concept, however, each of the cantons will provide the necessary infrastructure. Through its competencies in technology transfer, the EPFL will be in charge of the link with the academic dimension as part of its federal mission and responsibility. Some concrete and practical "démonstrateurs" will be developed locally in partnership with industry.

[27] Status as of December 11, 2014: the Message will be transmitted to Parliament in spring 2015.
[28] PNI = Parc National d'Innovation.
[29] See chapter C.2.2 below for details.

- The existing EPFL Innovation Park is the first stage and already a concrete example of what is intended to be developed together with the academic, economic and political partners.

PSI

- PARK innovAARE has resulted from the submission made by the Canton of Aargau with the support of the PSI.
- An innovation park is to be created in the immediate vicinity of the PSI. PARK innovAARE is intended to be a world-leading center, where, thanks to the PSI's expertise, innovations in the fields of accelerator technologies, advanced materials and processes, energy, and human health can be made ready for the market.
- With its complementary focus, PARK innovAARE integrates perfectly into the general concept of the Swiss Innovation Park.

Empa

- Empa actively supported the concept of a main National Innovation Park (NIP) hub on the Dübendorf airfield from a very early stage, and is now part of the consortium led by ETH Zurich. The proximity to the site as well as its strong ties to national and international companies make Empa a natural link to the hub of the Swiss Innovation Park at Dübendorf.
- Empa is also involved in the NIP Ostschweiz, a planned NIP network location close to Empa St. Gallen. Spearheaded by Empa's technology center tebo, a technology park is to be created in 2015 where companies that match Empa's competency profile can settle and explore new possibilities for collaborative projects.

B
National Position and International Competitiveness

B
National Position and International Competitiveness

Introduction

Switzerland enjoys a worldwide reputation as a research and science location and is extremely attractive at an international level. The institutions of the ETH Domain play a leading role here. This is reflected, for instance in the fact that both ETH Zurich and EPFL have for many years occupied top places in global university rankings. As is stipulated in the performance mandate bestowed upon them, the institutions of the ETH Domain aspire to the best possible quality in all their areas of research, in teaching, and in all other fields in which they are active. Only in this way can the ETH Domain fulfill its mandate in the Swiss context, by educating professionals, innovating, and performing tasks of national importance.

Core Prerequisites

Top-notch research, to which the ETH Domain is committed, has always had a global orientation. Thus researchers in Switzerland and researchers from Switzerland are engaged in a worldwide professional exchange but are also involved in a global competition – as are the institutions of tertiary education, for instance when it comes to attracting researchers and advanced students or retaining them in the institution by offering an attractive environment.[30]

This global orientation must also be a point of reference for a science policy that is guided by the national interest. In the ETH Board's opinion, the three following core prerequisites underpin the ETH Domain's excellent international position, and they are essential if it is to contribute to sustainable development globally and hence also in Switzerland.

- Switzerland's higher education and research institutions depend on being internationally embedded and on acting in a high-level international exchange so that they can fulfill their functions and generate maximum benefit for Switzerland's economy and society and thus for the country as a whole.
- So that they can operate flexibly and sustainably in this highly dynamic global environment, the institutions depend, in turn, on a high degree of autonomy, which – as far as the ETH Domain is concerned – they are granted by the currently applicable legislation, prevalent governance and political control.
- Such dynamic and independent action on the part of the institutions hinges on basic funding that is stable, reliable and can be used with highest possible flexibility, as it is stipulated for the ETH Domain by the performance mandate and the global budget arrangements.

[30] The bibliometric analysis of the ETH Domain confirms the importance of international collaboration in contemporary research, as it shows that, for all ETH Domain institutions, publications resulting from international collaboration clearly yield the highest impact (see chapter E below).

Science Policy

In the ETH Board's view, three aspects must be considered as a matter of priority:

- First, science policy is confronted with the fact that the above-mentioned prerequisites for success can clash with the goal of generating measurable benefit for society. The ETH Domain institutions (as well as the cantonal universities) are tasked to engage in long-term research and to proactively identify and address relevant research topics. Ideally, therefore, such topics are addressed within the ETH Domain institutions before they are treated as challenges for society at large. Thus, it can be difficult to measure the direct benefit to society of such research.
- Second, science policy must pay attention to increased regulation of research areas. Such regulation, and – even more often – its enforcement, can sometimes differ from canton to canton (for instance regarding the implementation of animal protection regulation). Attention must also be given to the effects of intensified programmatic weighting of certain fields of research (program-oriented research).
- Third, science policy must be able to counteract certain political developments that do not arise from science policy but, for instance, from migration policy, foreign trade policy, or economic policy.

B.1
Impact of Science Policy

"What impact does science policy have on the academic autonomy of institutions in the ETH Domain?"

B.1 Impact of Science Policy

Assessment by the ETH Board

Assets

The ETH Board embraces the fact that *science policy in Switzerland is characterized by* a long-standing tradition of *supporting the three core prerequisites for the success* of Switzerland's research and higher education institutions (internationality and openness, autonomy, stable basic funding). Accordingly, the ETH Board holds that

- the *autonomy* of the ETH Domain institutions as *granted by the ETH Act* has been a *key success factor* for their evolution;
- within this framework, the ETH Domain institutions currently have the necessary freedom with regard to the allocation of resources, and adequate freedom and opportunities to *determine freely their research priorities*;
- today, the ETH Domain enjoys a high degree of trust both in *government circles and in society*.

Challenges and Opportunities

With regard to priorities in science policy, the ETH Board is convinced that *six challenges deserve adequate attention*:

a) It must be a core objective of all actors involved in science policy to maintain the current degree of autonomy as a success factor of the ETH Domain and to *foster the culture of mutual trust* that is associated with it.

b) With regard to research funding, the right *balance between free (curiosity-driven) basic research and programmatic or application-oriented research* must be maintained. The ETH Board has observed, with great concern, political attempts to shift this balance away from basic research.

c) Academic and financial autonomy are a core value in science policy, but they require that a *better mutual understanding* by both sides (political and academic) be achieved in order to avoid exaggerated or misplaced expectations and disappointment.

d) On the level of the institutions, the ETH Board, and the Confederation, autonomy requires a *strong emphasis on good governance principles*: On the one hand, the ETH Board and the institutions must ensure that such principles are followed and communicated internally as well as externally. On the other hand, the ETH Board, together with the Confederation, should strive to counteract the tendency to increasingly regulate matters that jeopardize the dual autonomy of the ETH Domain and its institutions.

e) A *major change will be introduced* with the Higher Education Funding and Coordination Act (HEdA), taking effect as of January 1, 2015.[31] The ETH Board will need to effectively defend its strong position within the Swiss academic systems and carefully monitor the changes brought about by this Act in Swiss higher education.

f) All actors in the Swiss academic landscape, including the ETH Board and the ETH Domain institutions, must be even better prepared to *explain why internationality and openness are crucial* for the Swiss higher education and research institutions and how the country as a whole benefits from their international competitiveness.

"What impact does science policy have on the academic autonomy of institutions in the ETH Domain?"

[31] See the chapter "Perspectives of the ETH Domain" above p. 12ff.

B.1.1 Academic Autonomy

The autonomy which is granted to the institutions of the ETH Domain is of decisive significance to their operating framework.

- It allows the institutions of the ETH Domain to invest heavily and primarily in fundamental, disruptive and long-term research, which in turn makes them more attractive for cooperation with private companies.
- Science policy in Switzerland has, over the past decades, avoided excessive promotion of program-oriented research. Whenever the latter is challenged, science policy can indeed directly affect the academic autonomy of the ETH Domain institutions. This is the case most prominently if specific research topics are defined in the Education, Research, and Innovation (ERI) Message. Such "line item" funding decreases the flexibility to allocate funding between different research fields.
- Additionally, due to such funding, particular research areas – as it might be the case, for some institutions, with regard to energy research – may end by occupying a disproportionate place within the institution, which adversely affects their other areas of research.
- At the same time, this type of funding often does not reward previous investments of the institutions in this particular research area, i.e. it does not honor those who have set trends prior to the political agenda setting.
- Finally, such funding is linked to high expectations from the actors in politics and in society, which are likely to be disappointed due to the inherent complexity of scientific research (uncertainty, explorative nature, etc.). This, in turn, generates adverse effects on political support for science and research in general.
- As has been observed in the ETH Domain in recent times, science policy can also affect the academic autonomy of the institutions by re-orienting the balance between autonomy and coordination. It must be borne in mind that coordination always hinders quick and flexible reactions to changes in the academic environment and with regard to needs and opportunities of and for private and public actors. On the other hand, coordination can ensure a more effective use of public funds. Therefore, it is crucial for the ETH Domain and for all partners involved in innovation in Switzerland that the costs of lack of coordination and of over-coordination are well balanced. From the perspective of the ETH Domain, the current trend goes towards increasing coordination (including related costs[32]) and towards decreasing autonomy and flexibility at the risk of reducing the innovation potential of Switzerland as a whole.

B.1.2 Openness and Diversity

Another condition of crucial importance is openness on a global level, and particularly with regard to Europe.

- It enables the international nature of Switzerland as a center of tertiary education and the diverse experience backgrounds of scientists working in Switzerland to be used for trail-blazing research, teaching and KTT. In an educational environment characterized by internationality, Swiss students are effectively prepared for competition in business and industry as well as in academia in a global labor market.

[32] Examples include procurement regulations [Beschaffungsrecht] or the coordination within the new Higher Education Funding and Coordination Act (HEdA).

- Openness is equally important for attracting the best professors, researchers and students to the campus. The current crisis with the European Union has an impact on all institutions of the ETH Domain, as they have all achieved a very high level of competitive European funding. Even more important than the loss in terms of funding, however, is the fact that exclusion from competitive European funding programs would deprive researchers from Switzerland, in particular young academics, of the opportunity to engage in competition on the European level. This would seriously impair their ability to advance their academic careers and, therefore, significantly reduce Switzerland's attractiveness for world-class researchers from abroad as well as from Switzerland itself.[33]
- If they are to contribute to a sustainable development of the economy and society in Switzerland, the institutions of the ETH Domain must also be able to benefit from a concept of autonomy that rewards entrepreneurial spirit. Technology transfer, partnerships between the public and the private sector, and the institutions' philanthropy-driven scientific activities require responsible entrepreneurial working practices within the institutions.

[33] See, for instance, the article "ETH-Forscher kündigt wegen SVP-Initiative" in Schweiz am Sonntag, October 5, 2014, p. 9.

B.2
Cost-Intensive Research Infrastructures

"Do the ETH Domain institutions have the networks, competences and instruments necessary to play a leading role, in collaboration with international partners, in the development and operation of future cost-intensive (large-scale) research infrastructures which will benefit the Swiss higher education system? What competences and instruments are required and which should be developed in future?"

B.2 Cost-Intensive Research Infrastructures

Assessment by the ETH Board

Assets

Large-scale research infrastructures are focal points where *excellence in science acts as a driver for excellence in technology and education*. Considering experiences with past and current realizations of internationally competitive large-scale research infrastructures in the ETH Domain, the ETH Board holds that

- the institutions of the ETH Domain currently *play a leading role* with regard to the conceptualization, development and operation of world-class research infrastructures;
- they not only *host and develop large-scale research infrastructures* in Switzerland, but also *contribute decisively to the development of such infrastructures* at many places in international consortia;
- representatives of ETH Domain institutions are *sought-after experts* in such endeavors;
- the *ETH Domain institutions benefit* from their privileged global networks, their outstanding knowledge, and the general reputation of the individual institutions;
- their embedding in international networks allows for an *efficient distribution of tasks and profiles* among the international infrastructures, for instance in the field of high performance computing, which enhances their effective use;
- Switzerland as an academic and an economic location benefits from the high level of involvement of the ETH Domain institutions in such networks, both regarding *increases in scientific expertise and the specific innovations* it promotes;
- the development of large research infrastructures boosts *technology transfer* through intensified collaboration with industry partners during the development and construction phases and through spin-offs.

Challenges and Opportunities

The conceptualization, establishment, operation and exploitation of large-scale research infrastructures are increasingly *taking place in international networks*. The ETH Board is convinced that in an academic environment like the ETH Domain, in which internationality is of eminent importance, the sustainable operation and the *efficient and innovation-fostering use of such research infrastructures is in the best possible hands*. However, *five challenges* need to be considered in respect of future development:

a) Protecting *internationality and academic openness* is also a core requirement with regard to the ETH Domain's role and contributions regarding large-scale research infrastructures.

b) Free and non-bureaucratic *access for researchers worldwide* should continue to be granted, a principle which has always been applied in a reciprocal manner, benefitting Swiss researchers at infrastructures abroad as well.

c) *Coordination on the national level*, including among ETH Domain institutions, needs to ensure that existing strengths are most effectively used and are well balanced against the autonomy of the institutions to set their academic and infrastructural priorities.

d) The institutions must be enabled to guarantee *continuous reinvestment to keep the existing large-scale facilities competitive at the international level* and to allow trend-setting in selected areas.

"Do the ETH Domain institutions have the networks, competences and instruments necessary to play a leading role, in collaboration with international partners, in the development and operation of future cost-intensive (large-scale) research infrastructures which will benefit the Swiss higher education system? What competences and instruments are required and which should be developed in future?"

e) Most large-scale infrastructures of the ETH Domain are open to international users though competitive access calls. In addition, several EU research institutes have funded and currently run beamlines at the national large-scale facilities of the PSI. These *lean and efficient international collaborations should be preserved and could potentially serve as models for international collaborations at future Swiss national infrastructures*.

According to the ETH Domain's performance mandate as well as the "Swiss Roadmap for Research Infrastructures", the ETH Domain has a specific responsibility to develop new and improve existing research infrastructures of national importance, ensuring open access for research communities. It is through the ETH Domain institutions that the Confederation puts world-class research infrastructures at the disposal of the scientific community in Switzerland.

B.2.1 Examples

The following infrastructures within the ETH Domain may be cited as examples:

- The *Swiss National Supercomputing Center (CSCS)* operates, under the auspices of ETH Zurich, the world's most energy-efficient petascale supercomputer and one of Europe's two leading systems (the other being at the Julich Supercomputing Center in Germany):
  - The system at CSCS was co-developed with Cray and NVIDIA along with leading application codes, and is one of three productive GPU accelerated high-end supercomputers in the world.[34]
  - These types of system architectures are one of the paths on the way to exascale computing, as they have far superior energy efficiency than other, more traditional supercomputing systems.
  - CSCS' petascale system is presently the most energy-efficient high-end system worldwide.
  - CSCS is thus one of the leading players, and in this regard maintains a lead over other centers in Europe. Furthermore, the Swiss high-performance computing and network (HPCN) program has consistently invested in application and algorithm development for high-end computing systems.
  - The research community in Swiss academia that is associated with this program is thus in a leading position to develop the simulation tools of the future.
- The *Centre de Recherches en Physique des Plasmas* (CRPP) was developed over the years with a substantial contribution from EPFL and Euratom, and is considered one of the finest in Europe.
  - The CRPP benefits from world-class facilities, including the tokamak TCV, a wide range of measurement devices, a millimeter wave high-power laboratory, and a laboratory for industrial plasma processes.
  - This enables the CRPP to carry out high-level plasma physics and fusion energy research, which represents an important contribution to the enhanced national effort to develop novel energy resources.

[34] The two others are located at Oak Ridge National Laboratory and at the Tokyo Institute of Technology.

- The *Blue Brain Project* was initiated in 2002 by EPFL as a long-term, large-scale project integrating simulation science, neuroscience, and supercomputing.
  - In 2011, the Blue Brain Project was recognized by the ETH Board and by SEFRI as national infrastructure, and since then benefits from dedicated funding by the ETH Board.
  - In 2012, the *Human Brain Project*, of which the Blue Brain Project is the core simulation platform, was selected by the European Union as one of two "FET Flagship Projects".
  - The Human Brain Project can be seen as a model of a modern collaborative project in high-performance computing, simulation, neuromorphic technologies, and medicine.
  - Today, the HBP consortium comprises 112 partner institutions from all over Europe.
- The PSI presently hosts three research infrastructures that are among the best of their kinds on an international level (SLS, SINQ, SμS[35]) in addition to the facility currently under construction (SwissFEL). This gives the PSI a unique position worldwide by offering access to the most important and complementary probes for materials science: photons, neutrons, and muons. Efforts to continuously upgrade the instrumentation guarantee state-of-the-art research opportunities for the national and international research community and assure the PSI a trendsetter position in the coming years.
  - The best example of the PSI's competency and networking activities is the realization of the next generation large-scale research infrastructure *SwissFEL*. The focus of the research activities at the SwissFEL will be on structural biology and protein research (investigating dynamic processes) and on the examination of innovative materials for catalytic processes and information technology. The knowledge gained at the interface between fundamental and applied science will also be beneficial to the Swiss economy. Findings from SwissFEL could be applied by companies involved in drug research, chemical processes or in the use of new technologically relevant materials. The excellent quality of the measuring stations has also made the PSI a sought-after partner for developing international large-scale research facilities. Complementary to the in-house effort, the PSI supports the construction of the European X-ray free electron laser (XFEL) in Hamburg, Germany, and the European Spallation Source (ESS) in Lund, Sweden, through contributions in kind.
  - The large-scale research facilities are also of crucial importance for the education and training of young scientists. Countries with large-scale national research facilities are distinctly more successful in the competition to make use of international large-scale research facilities abroad. Swiss researchers have a proven track record of being extraordinarily successful at international facilities, such as ILL and ESRF (both Grenoble, France). PSI cultivates an outstanding international network, as reflected in the user statistics for its large-scale research facilities. Approximately half of the beamtime is allocated to scientists from abroad, particularly from countries in the EU. Beamtime for these academic users is granted solely on the basis of scientific excellence. Furthermore, PSI staff members are involved in a number of advisory boards for national and international research infrastructure projects, testifying to the recognized competencies of PSI in this technological field.
  - Furthermore, the ERID Watch project[36] has also shown that research infrastructures have a direct market impact in several areas: as suppliers of cutting-edge research, as buyers of high technology products and services, as providers of scientific advice, and as sellers of state-of-the-art services to both public and academic users of the facilities. The Swiss Light Source at PSI has a significantly higher proportion of direct industry use (>10 %) compared to other synchrotrons worldwide (5–7 % on average).

[35] The three acronyms stand for the following three large infrastructures hosted by the PSI: SLS = Swiss Light Source; SINQ = Spalliation Neutron Source; SμS = Muon Source.
[36] See chapter A.1.1 above, footnote 16.

B.2.2 Success Factors

Special instruments that are needed in order to maintain the relevant competencies and the proven excellence in the development and operation of large-scale research facilities are:

- Continuation of challenging projects at the national level in order to retain trend-setter status (Example: SLS was one of the first national synchrotrons, and SwissFEL will be one of the first national free electron X-ray lasers worldwide);
- possibility to contribute under international law to research infrastructure projects abroad (e.g. through in-kind contributions);
- possibility to join ERIC (European Research Infrastructure Consortia) as full partner;
- exchange of staff between research facilities.

These requirements again point to the crucial importance of Switzerland's openness and international attractiveness.

Another important element in this context concerns the Swiss research infrastructure "culture": in Switzerland, research infrastructure is generally of high quality and is constructed in an open manner, giving access to all national and international partners (e.g. Swiss Light Source, CRPP, SwissFEL). Therefore, when big international projects are initiated, Swiss researchers and infrastructure are "natural" partners (e.g. ESS, ITER, LHC, European XFEL). It is therefore essential to continue investing in open-access infrastructure in the ETH Domain and on the national level.

B.3
Benefits for Switzerland

"Are the ETH Domain institutions managing to reap benefits from their strong position on the international competitive stage, both for industry and technology in Switzerland and for the Swiss higher education institutions?"

B.3 Benefits for Switzerland

Assessment by the ETH Board

Assets

Internationality and openness of Switzerland as a center of education and research represents the central prerequisite thanks to which the ETH Domain succeeds in creating social and economic benefit. The ETH Board is convinced that

- the institutions of the ETH Domain *use their excellent international position for the benefit of Switzerland*, its national economy, its public administration and private enterprises, its universities, and its educational system;
- this benefit *derives in the first place from the ETH Domain's high-quality and internationally embedded research and teaching* activities;
- this embedding of the ETH Domain's activities makes it possible to *attract world-leading scientists and students*, with whom both academic and economic actors can collaborate and who offer their knowledge and skills on the Swiss job market;
- the *excellent international position of the ETH Domain institutions* fosters Switzerland's reputation in both academic and economic terms, and generates positive impact;
- the *institutions' activities in the field of KTT*[37] represent a crucial element of fostering Switzerland's capacities with regard to innovation;
- the *institutions are aware of their important societal role* and thus also use their resources to ensure that such benefit is as sustainable and effective as possible. As particular instruments, they have developed an intensive collaboration with the economy, a wide range of KTT activities, and a growing life-long learning offering, plus individual and institutional cooperations with academic partners among the universities and Universities of Applied Sciences.

Challenges and Opportunities

The excellent international position of the ETH Domain institutions is their *most important asset* in global competition among higher education and research institutions. In the ETH Board's view it cannot be emphasized too strongly that the ETH Domain succeeds in creating social and economic benefit primarily due to this strong international position. This raises *three specific challenges*:

a) Global competition among higher education and research institutions entails competition for the best students, young academics, experienced researchers, and promising research projects, but also for participation in research alliances, for promoting and deploying novel educational technologies and for attracting research departments of large international companies to Switzerland. Both the openness and the attractiveness of Switzerland and its economy must therefore receive the utmost attention, while the *internationality of higher education and research must be established as a central guideline of science policy*.

b) The ETH Domain institutions must be able to *attract young academics worldwide* – including those trained in Switzerland – and to offer them attractive development opportunities both within and outside academia. This calls for a continuation of *current strategies for the promotion of young academics [Nachwuchsförderung]*. As excellence attracts excellence, Switzerland as a scientific and an economic location, as well as the young Swiss academics themselves, benefit from this approach.

"Are the ETH Domain institutions managing to reap benefits from their strong position on the international competitive stage, both for industry and technology in Switzerland and for the Swiss higher education institutions?"

[37] See chapter A.1 above for a detailed development.

c) The ETH Domain institutions must remain empowered to constantly *shape and develop their curricula* – including their offering in the area of continuing education – *by addressing the trends set by cutting-edge science as well as the needs put forward by the economy (in particular industry) and society*. This underlines the importance of granting autonomy and flexibility to the institutions.

B.3.1 Social and Economic Benefit

First and foremost, the institutions of the ETH Domain produce overall social benefit through their fundamental mission. They provide research at the highest level as well as research-based teaching to educate highly specialized professionals. Through their extensive activities in the field of knowledge and technology transfer they guarantee that the results of the research conducted in the ETH Domain can be harnessed for specific applications, and that innovative solutions can be tested on the market and made available to society. In the ETH Board's view, direct or indirect social and economic benefit generated by the ETH Domain institutions can be further illustrated by the points highlighted below. They contain elements from teaching, research, and/or KTT.[38]

"Technologization of Industry"
The institutions of the ETH Domain consider that one of their tasks is to contribute to the "technologization" of our industry by training the future engineers who will work for Swiss firms both in Switzerland and abroad.

- By welcoming foreign students, the ETH Domain institutions are training the young talents who will one day work for these companies and represent Switzerland throughout the world even after returning to their country of origin.
- The same applies to students from the ETH Domain who in the future will work as engineers for foreign companies that create jobs in Switzerland.
- An important contribution is therefore constituted by *Innovation or Technology Parks* in which the institutions are already involved. Thus ETH Zurich has spear-headed and has been associated with Zurich's Technopark – Switzerland's first industry-academia park – ever since its establishment in 1993; various ETH Zurich institutes and more than 20 ETH Zurich Spin-offs at any point in time are accommodated on approx. 7,000 m^2, contributing to the home of close to 300 companies (of which 140 start-ups) and 2,000 jobs that spread over the total surface of ca. 50,000 m^2, making the Technopark Zurich a truly intertwined transfer center.
- Similarly, the EPFL Innovation Park ("Innovation Square") and the 2,000 R&D jobs created there are the main bridge for technology transfer between EPFL cutting-edge science and the world of industry. The facility hosts more than 100 spin-off/start-up companies and enables companies based nearby (such as Nestlé, Logitech, Credit Suisse, Debiopharm, Cisco, and Axa), to place their R&D units close to the scientific heart of EPFL, with its innovative atmosphere, laboratories, professors, and students. Likewise, it offers the latter an opportunity to become familiar with the business world and to contribute to the Swiss economy of tomorrow.

[38] The following examples, however, do *not specifically focus on benefit generated for higher education and research institutions, as this question will be addressed in part C.3 below*, which specifically assesses contributions to the improvement of the Swiss higher education system as a whole.

– The ETH Domain institutions are able to exploit the excellent fit between research and technology developments in ETH Domain institutions and the specializations of the Swiss economic actors – both with regard to current industry specializations and emerging or future fields of industrial activity.

Political Decision-Making
Finally, all institutions of the ETH Domain cultivate excellent relations with public administration at the federal, cantonal and municipal levels. Through their expertise, which benefits all these levels in a wide variety of ways, the institutions make essential contributions to fact-based political decisions and – in particular – to an implementation of laws and ordinances to standards of state-of-the-art research (e.g. codes of practice in the field of civil engineering).

B.3.2 Added Value of Existing ETH Domain Locations

Many companies explicitly state that proximity to an ETH campus was a reason for their choice of location. At the EPFL Innovation Park, for instance, proximity to the campus was a key factor for large companies to set up. For companies, being present on a campus is a good opportunity to stimulate and accelerate innovation, as well as to scout new technologies and gain access to top-notch researchers and talents.

– Examples of firms close to ETH Zurich include IBM, the association of Disney Research labs, Google, and Bruker.

– At EPFL Innovation Park, companies such as PSA Peugeot Citroën, Nestlé, Logitech, Bühler, and Nitto benefit from their proximity to the EPFL campus.

The direct economic significance that the institutions of the ETH Domain have in their respective regions must not be underestimated either. Evidence of positive direct or indirect economic effects could be produced for each institution but can be shown most distinctly through the position of the Federal Institutes of Technology.

– Figures for ETH Zurich include:
  – Annual turnover: approx. 1.5 billion CHF;
  – over two thirds of ETH Zurich's turnover remains in the Canton of Zurich: 80 % of the wage bill paid to employees resident in the Canton of Zurich, i.e. about 740 MCHF; additionally, about 44 % of ETH Zurich's investment spending (approx. 240 MCHF);
  – 2011 graduate survey (conducted by FSO): 91 % of all graduates of a degree course (Master's degree or diploma) and 76 % of all graduates with doctoral degree work in Switzerland 1 year after completion of studies;
  – students generate value in excess of 350 MCHF per annum in the Canton of Zurich.[39]

– Figures for EPFL include:
  – over 15,000 persons study or work at EPFL, a majority of them living in the Canton of Vaud;
  – 816 master students and 414 PhD students graduated in 2013. A survey showed that about 75 % of the master graduates and 58 % of the doctoral graduates from 2012 were residents in Switzerland, and more than 92 % of those had an employment after one year.

[39] According to calculations by ETH Zurich and the University of Zurich, students' tuition and living costs in Zurich amount to about CHF 24,000 per year. For the number mentioned above, the full amount was factored in for the 66 % of students who live in the Canton of Zurich, whereas half this amount was used for the remaining 34 % of students who live outside the Canton.

  - 1,950 jobs were generated by companies that are located at the EPFL Innovation Park, including the services companies.

- The numerous spin-offs launched in close proximity to ETH Zurich and EPFL because of these two institutions' efforts in this respect and their entrepreneurial spirit, also generate significant benefits for their immediate location, not least with regard to the jobs and the tax income they generate.
- In the global competition between knowledge locations, the respective home regions of the ETH Domain institutions also profit from the impact and excellent reputation of these locations. This applies to the two Institutes of Technology as much as to the Research Institutes, as international cooperation relates to scientific exchange and international research contacts (including value creation, which is generated by scientific congresses, for example) and to cooperation with actors from trade and industry both in Switzerland and abroad.

C
Federal and Higher Education Policy

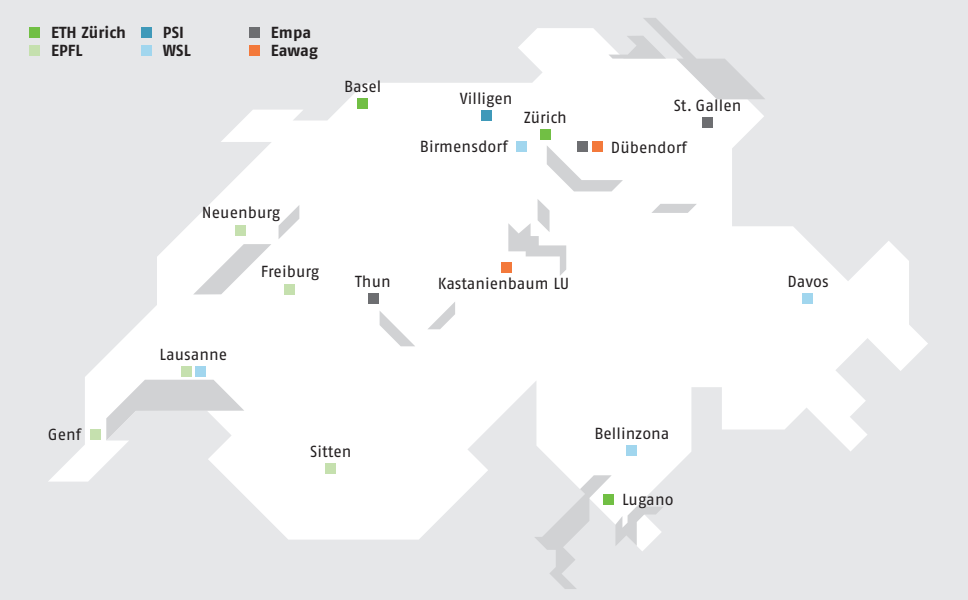
C
Federal and Higher Education Policy

Introduction

Thanks to the unique features of the ETH Domain, to the outstanding performance of the individual ETH Domain institutions and to the strong support it receives from the Confederation as its owner and from Switzerland as a whole, the ETH Domain occupies a strong position in the Swiss academic landscape. The unique features of the ETH Domain encompass the following main aspects[40]:

- The combination of exact, natural and engineering sciences and their association with social science and humanities (including economics): The ETH Domain is the only actor in Switzerland capable of offering such a wide range of specialization and corresponding research and teaching activities.
- The complementary relationship between the two Federal Institutes of Technology and the four Research Institutes: While the two Federal Institutes are engaged in teaching based on the world-class (and mostly fundamental) research they perform, as well as in intense KTT activities, the four Research Institutes specialize in top-level thematic research as well as in applied research in their focal areas and in technology development.
- The research infrastructures of national importance hosted by the ETH Domain institutions: Many of Switzerland's highest-standard and state-of-the-art research infrastructures and large-scale facilities are operated within the ETH Domain as user labs, allowing researchers from Switzerland and abroad to make use of this unique infrastructure.

Fig. 3: The current regional embedding of the ETH Domain institutions



[40] See chapter "Perspectives of the ETH Domain" above and Appendix 1.

In addition, the institutions of the ETH Domain benefit from being very strongly rooted in Swiss society and in the Swiss economy. The ETH Board is convinced that this represents an important asset of the ETH Domain, and is key to its aim of contributing with high impact to innovation and economic development in Switzerland. One aspect, strengthening these roots and serving the high reputation of the ETH Domain in all parts of Switzerland, is the fact that all regions of the country host one of its institutions or one of their branches.

The fact that the ETH Domain has always been able to benefit from stable and long-term basic funding by its owner, the federal government, and the long-standing roots and corresponding support of the ETH Domain within society, the economy and government is a further core asset complementing the ETH Domain's unique features and strong embedding.

For the ETH Board, these assets are key in terms of the sustainability of the ETH Domain and its institutions, their medium- and long-term development, and regional embedding and cooperation within the Swiss academic system. It is by developing these assets sustainably and exploiting their potential in cooperation with partners inside and outside academia, but also by maintaining the ambition to compete with world-leading institutions in their respective fields, that the ETH Domain institutions can best contribute to the development of the Swiss higher education system and the ongoing quest to advance and foster innovative capacity throughout Switzerland.

C.1
Geographic Developments

"What assessment can be made of the increasing regional expansion of the individual ETH Domain institutions? What impact will this have in terms of their funding, independent decision-making and autonomy?"

C.1 Geographic Developments

Assessment by the ETH Board

Assets

The historic and political reasons for the existing presence of ETH Domain institutions in the different regions of Switzerland and outside the country vary. In this regard, the ETH Board recalls that

- all ETH Domain institutions except the PSI operate *more than one site*;
- ETH Zurich and EPFL each are also present at one location *outside of Switzerland*;
- the institutions of the ETH Domain *operate in 13 cantons* (including the new locations that are in preparation);
- in the recent past, most institutions have not developed additional sites, but have *strengthened their existing locations*;
- EPFL is implementing a strategy of fostering its presence in the French-speaking part of Switzerland through its *concept of creating regional antennae*;
- the ETH Domain's regional embedding is an *important element explaining the deeply rooted support* from which it benefits throughout Switzerland.

In the light of this state of affairs and of recent experience, the ETH Board considers that

- geographic expansion (both national and international) can present *opportunities compatible with the strategic priorities and objectives* set for the ETH Domain;
- geographic expansion of the ETH Domain institutions in the recent past has *followed clear objectives and well-defined criteria*: excellence, critical mass, taking advantage of unique opportunities;
- geographic expansion of ETH Domain institutions has in every case been *decisively supported* by the willingness of political authorities (such as cantonal governments), other higher education partners, and private companies to substantially and sustainably contribute in terms of resources and investment to the realization of the respective projects.

Challenges and Opportunities

Approaches and attitudes to regional expansion vary among the institutions of the ETH Domain. This is due, among other reasons, to differing perceptions of the opportunities and risks such endeavors entail, not only with regard to the particular project but also with regard to the general trends shaping the academic landscape of the future. With regard to the highly dynamic environment in which the ETH Domain performs, regional expansion raises *three main challenges:*

a) The institutions as well as the competent authorities, in particular the ETH Board, must be able to *ensure that decisions regarding geographic expansion result from carefully evaluated strategic choices*. To this end, decision criteria must be defined[41] and re-evaluated in light of experiences gained, and the governance structures in place must allow for fruitfully balancing autonomy on the one hand and strategic controlling on the other.

b) Although the ETH Board estimates that at present, the *opportunities* of the current expansion strategies, both regarding EFPL's antennae in Western Switzerland and the two schools'

"What assessment can be made of the increasing regional expansion of the individual ETH Domain institutions? What impact will this have in terms of their funding, independent decision-making and autonomy?"

[41] Currently, a task force mandated by the ETH Board (composed of representatives of the ETH Domain institutions and the ETH Board) is preparing a proposal for a strategy for international subsidiaries of the ETH Domain.

international commitments in Singapore and the United Arab Emirates (RAK), clearly *outweigh the strategies' risks*, the institutions and the ETH Board must be able to proceed to an *in-depth risk-assessment of a given expansion strategy*. Strategic risks must be balanced against the benefits to be realized through the geographic expansion. *Such risks are linked in particular to the long-term commitments the projects entail and to the requirement that a critical mass needs to be reached and maintained in the long term in order to ensure the quality of research and teaching at the various sites*. Under these premises, and taking into account the experiences ETH Zurich and EPFL have made through their cooperation with Singapore and Ras-al-Khaimah (RAK) respectively, the ETH Board will *continue to monitor* the geographic expansion of the ETH Domain institutions.

c) The institutions as well as the ETH Board must pay particular attention, in any geographic expansion, that the *internal balance of the institution is maintained*. This regards issues such as the capacity for internal cooperation, management resources required for new locations, infrastructural needs (duplication of costly infrastructure) and corresponding obligations, or mobility costs.

Criteria for Regional Cooperation

In order to ensure the sustainability of the regional branches and to minimize their strategic risks, the ETH Board has noted the criteria the institutions want to follow when engaging in regional cooperation. While the first three criteria are considered mandatory, the latter two are additional favorable elements. The following points summarize the most important aspects the criteria addressed:

- *Academic coherence:* Each geographic development project must ensure that it is compatible with the institution's strategy. Developing a new focal area around particular topics at a new location must generate added value that could not be generated if the corresponding focus were developed at the institution's main campus. Such added value can result from the peculiarities of the regional context (such as environmental, political, or cultural aspects) as well as from particular opportunities related to the presence and the excellence of academic or economic partners on site.
- *Academic responsibility:* The institution must be granted full academic responsibility with regard to the projects it enables within the regional branch. This is of particular importance when chairs and other staff positions are financed by the canton and/or by private funders. It entails full freedom with regard to recruiting scientific staff (professors, researchers) and an assurance that they are granted full academic autonomy. It also means that the institution must be entitled to (re)integrate the corresponding scientific staff to its main campus should the respective antenna project fail or be interrupted.
- *Critical mass and international competitiveness:* The institution engages in collaboration projects with the aim of increasing its capacity to deal with scientific issues where the ETH Domain is in global competition with the world's leading scientific institutions. Critical mass at the regional locations must be guaranteed. Thus, a geographic expansion project must contribute added value in terms of Switzerland's competitiveness and innovative capacity and thus meet the economic and political actors' expectations of the ETH Domain.
- *Financial agreements:* The financial aspects of the collaboration with a canton (or a country) and the distribution of costs must be clearly defined from the outset (e.g. with regard to the infrastructure investments a canton (or a country) is willing to contribute). If applicable, this also entails possible schemes for the co-financing of operational costs. Not least, financial agreements must also extend to the eventuality of the project failing.
- *Coherence with regional competencies and the regional industrial characteristics:* The scientific issues on which a regional branch focuses must be relevant with regard to the

region's industrial and economic characteristics. Such proximity makes it possible to generate additional benefit in terms of innovation as well as knowledge and technology transfer, contributing to the region and to the achievement of the ETH Domain's strategic goals. At the same time, it favors the establishment of additional networks or strategic partnerships with economic actors from the respective region (e.g. through funding of professorships).

With regard to recent developments in the locations and branches of the ETH Domain institutions, two processes need to be distinguished. On the one hand, all institutions have strengthened their main and their regional branches through site development and increased cooperation (C.1.1). On the other hand, in an initiative aimed among other things at deepening the ETH Domain's embedding and impact in French-speaking Switzerland, EPFL has developed a strategy of regional expansion through the creation of new regional antennae (C.1.2).

C.1.1 Strengthening Existing Locations

Over the past decades, ETH Zurich and the Research Institutes have expanded gradually and carefully. In terms of existing academic opportunities, they benefit mutually from their proximity to each other in the Zurich area. They have thus rather followed a strategy of strengthening and further developing their existing locations. In the recent past, they have undertaken the following site development processes at various locations:

ETH Zurich

1) Basel

- The Department of Biosystems Science and Engineering (D-BSSE) of ETH Zurich in Basel was established in 2007. It is dedicated to interdisciplinary research and development in the area of life sciences.
- Currently, D-BSSE hosts 17 professors with expertise in Experimental Biology, Theory, Biotechnology, Biophysics, and Microelectronics. It will be expanded to 20 professorships, with a new building at Schällemätteli ready for occupation by 2020.
- D-BSSE's main academic partners are the University of Basel and the University of Zurich. Cooperation with the University of Basel is characterized by three joint professorships (ETH Zurich and University of Basel), a joint Bachelor and Master program in Biotechnology, and a jointly planned and operated infrastructure.
- The creation of D-BSSE and the corresponding collaboration in the Basel area have been driven by a political mandate. ETH Zurich expects this to yield benefit for the institution in terms of opportunities and synergies at a location (Basel) renowned for its high standing and great potential in the field of biomedical and biotechnological research.

2) Ticino

- In the Canton of Ticino, ETH Zurich operates the Swiss National Supercomputing Centre, the *Centro Svizzero di Calcolo Scientifico* (CSCS).
- This user lab supports all higher education and research institutions in Switzerland (including, very prominently, EPFL and the Research Institutes) and is at the heart of the institutional collaboration between ETH Zurich and the *Università della Svizzera Italiana* (USI).

- Located at Manno since 1991, the CSCS moved to a state-of-the art building at Lugano-Cornaredo in 2012. In scientific terms, the Ticino branch of ETH Zurich focuses consistently on high-performance computing, but also on economics and architecture. To date, there are two joint professorships with USI.
- Furthermore, ETH Zurich has a strategic alliance with the *Istituto di Ricerca in Biomedicina* (IRB) at Bellinzona, one of the private institutions that are co-funded by the Swiss Confederation under Art. 15 of the Act on Research and Innovation.
- The CSCS was established in Ticino as part of ETH Zurich's national mandate and as a consequence of a policy decision. ETH Zurich has seized the scientific opportunities deriving from the associated regional expansion: it has been able to engage in beneficial cooperation with USI and has been granted the opportunity to develop a top-level facility for high-performance computing research in a supportive environment.

3) Singapore

- As an international strategic initiative, ETH Zurich has since 2010 been setting up the Singapore-ETH Center for Global Environmental Sustainability (SEC). In its launch phase, this initiative is being financed mainly by the National Research Foundation (NRF) of Singapore.
- While the initial contract was signed for five years, the NRF has declared its interest in continued collaboration. This is underscored by the long-term commitment it has expressed through the construction of the "CREATE campus", hosting not only ETH Zurich but the local branches of several other world-leading universities (e.g. TU München, MIT, Cambridge University) and the two universities of Singapore.
- At SEC, more than 150 researchers and students participate in the Future Cities Laboratory research focus program. This program provides the ETH researchers with unique opportunities to study pressing issues relating to sustainable urban development in a geographical environment and on a scale not found in Switzerland. FCL therefore includes activities in other fast-growing urban regions worldwide (e.g. Mumbai, Addis Ababa, and Sao Paolo). In November 2014, a second project on "Future Resilient Systems" has started at SEC.
- Most importantly, however, SEC also offers great opportunities to Swiss economic actors (including SMEs and ETH spin-offs), as it contributes to opening up new markets and will potentially generate valuable findings for the Swiss economy. For instance, SEC Value Lab Asia facilitates a fruitful exchange between industry and business through workshops and conventions held at the facility.
- ETH Zurich's activities at SEC not only help to strengthen its reputation and visibility in the Asian context, but also generate interesting opportunities for science and economy in Switzerland as a whole. While scientific benefits are the core motive for engaging in this international collaboration, ETH Zurich has been convinced, from the outset, that it will generate highly relevant added value for other Swiss actors too.

Research Institutes
With the exception of the PSI, all Research Institutes operate two or more branches. Their creation has been linked to historical developments and to the nature of their tasks:

- *WSL* has its main campus at Birmensdorf, close to Zurich. It has one branch at Davos (founded in 1931), focusing in particular on snow research and avalanche prediction. To take account of the special characteristics of the environment south of the Alps, WSL set up a third location in 1991: a branch in Bellinzona in the Canton of Ticino. Here the cooperation with Agroscope will be strengthened through the use of joint facilities in a new Agroscope building. A fourth location in Lausanne (founded in 1991) mainly covers the special environmental characteristics of western Switzerland. Since 1995, WSL collaborators have also been located in Sion, where they work on natural hazards in mountainous regions.
- The head office of *Empa* is located at Dübendorf, where it shares a number of facilities (e.g. library, childcare center) with Eawag on a joint campus. However, Empa also has important locations in St. Gallen (established in 1937) and Thun (1994). Furthermore, it will be linked into the EPFL antenna projects in Sion and Fribourg.
- Besides its main campus in Dübendorf, *Eawag* has a branch at Kastanienbaum (since 1960) in the Canton of Lucerne, with aquatic research labs and direct access to one of Switzerland's largest lakes.

While in some locations, major site development projects were undertaken (e.g. major renovation of the Eawag laboratory building at Kastanienbaum) or are projected (e.g. at the Empa site in Thun) and strategic investments in research infrastructure are continuously being realized at the main campuses (such as SwissFEL at PSI Villigen, NEST at Empa Dübendorf, the National High Security Plant Protection Lab at WSL Birmensdorf and the experimental research ponds at Eawag Dübendorf), the Research Institutes do not currently have any regional expansion plans. At the same time, concentration processes that would include reducing the number of locations in which the Research Institutes are active have been subject to strong political opposition, both on the level of the cantons concerned and on the national level. The ETH Board sees this as reflecting the great importance and added value of its institutions' regional branches in each of the corresponding local contexts. Therefore, despite potential synergies that might be realized through geographical concentration, no such processes are currently under way.

C.1.2 EPFL Antennae Strategy

While both German-speaking and, to some degree, Italian-speaking Switzerland have benefitted for many years from a strong presence of five ETH Domain institutions, the French-speaking part of the country has solely hosted EPFL with its campus at Lausanne-Ecublens.[42] In order, among other things, to strengthen the ETH Domain's presence in Western Switzerland and to further contribute to the region's economic development, EPFL is implementing a strategy for geographic development. It focuses on the creation of regional antennae in the Cantons of Neuchâtel, Valais, Geneva and Fribourg.

By targeting existing collaborations and the specific economic and/or scientific strengths of the respective locations, EPFL is aiming to increase the visibility of the ETH Domain and of Switzerland as a scientific location in general. Furthermore, it seeks to encourage stronger long-term institutionalized collaboration with academic partners, in particular universities and Universities of Applied Sciences that are already present at the respective cantonal locations. Together with the fact that the antenna strategy is also destined to strengthen specific

[42] EPFL, however, has been the leading ETH Domain institution at the CSEM Competence Center (Neuchâtel) ever since the latter's foundation. Furthermore, two branches of WSL are located in Western Switzerland.

academic domains and diversify EPFL's income sources, the general objectives of the strategy are coherent with the ETH Domain's performance mandate for the period 2013–2016 and the ETH Board's strategic planning.

EPFL has developed four regional antenna projects in Western Switzerland and is running one antenna in the Middle East. These projects are briefly presented below:

1) Microcity Neuchâtel

- Since 2011, the Canton of Neuchâtel has invested 72 MCHF in the "Microcity" building in Neuchâtel. Since 2014, 600 EPFL researchers have been working at Microcity on an area totaling 23,000 m^2.
- To date, 11 chairs have been installed at Neuchâtel, one of which is endowed by PX Group and one by Patek Philippe.
- The EPFL engagement at Microcity Neuchâtel not only serves to strengthen its ties with the local watchmaking industry, but also permits closer collaboration with the CSEM and helps to strengthen its *Centre de technologie photovoltaïque*, which is supported by the Confederation.
- For EPFL, Microcity Neuchâtel is also an ideal location for developing its research focus on advanced manufacturing.

2) EPFL Valais Wallis

- The EPFL antenna Valais Wallis involves the setting-up of around 11 chairs, seven of which will be financed by the Canton of Valais. As of 2015, a first building at Sion will host the first EPFL teams.
- The research priority at EPFL Valais Wallis is energy, focusing on issues such as hydropower, water management, energy resources for industry, energy management (in collaboration with CREM at Martigny), and green chemistry (energy storage, utilization of CO_2). Technical platforms related to these areas of research will also be developed.
- At the Sion campus, the University of Applied Sciences Valais (HES Valais) will be located in the immediate vicinity of EPFL Valais Wallis, facilitating collaboration and creating synergies as well as opportunities for joint development and use of technology platforms.
- Finally, collaboration in the health sector with SUVA (the Swiss Accident Insurance Agency) and the cantonal hospital at Sion is also being targeted. An EPFL team started working in this field in November 2013.

3) Campus Biotech Geneva

- Campus Biotech Geneva will be realized at the former Merck/Serono premises in Geneva. At this location (known as the Sécheron site and located close to the Geneva-based branches of numerous international organizations, including WHO), EPFL and its partners will realize the Wyss Center for Neuro- and Bio-Engineering.
- Focusing on neurosciences and bio-engineering, Campus Biotech will be developed by EPFL in close collaboration with the University of Geneva, present at Campus Biotech with a research team since 2014, and the Geneva University Hospital (HUG – Hôpitaux Universitaires Genevois). Two EPFL chairs at Campus Biotech Geneva will be endowed by M. E. Bertarelli and one chair by Medtronic.

- Campus Biotech will host EPFL's prestigious Human Brain Project, its Center for Neuroprosthetics, and the planned Lemanic Center for Personalized Health.[43]

4) Smart Living Lab Fribourg

- In Fribourg, the Canton of Fribourg aims to implement the ambitious "Blue Factory" development project on the former premises of the Cardinal brewery.
- In this context, EPFL has engaged in a collaboration project with the University of Fribourg and the Fribourg University of Applied Sciences. This collaboration will focus on sustainable construction and civil engineering. Within the project, seven chairs will be installed, three of which are financed by the Canton of Fribourg, two by external partners, and two by the University of Fribourg. Moreover, the Fribourg University of Applied Sciences will base two research groups at Blue Factory.
- The program will be built around three poles, namely
  BUILD – Future "Smart Living Lab" Building
  ACAD – Academic center of expertise
  DEMO – Demonstrator, workshops and public outreach

5) EPFL Middle East Ras-al-Kaimah

- The EPFL Middle East program at Ras-al-Kaimah (RAK) was launched in 2010 to seize opportunities in the Gulf region for pursuing specific research activities in such fields as energy, sustainable development, transport, and urban planning.
- In 2011, the EPFL Energy Management and Sustainability master program was launched within EFPL Middle East, and the first students graduated from this program in 2013.
- Likewise, several EPFL labs have engaged in research projects with EPFL Middle East; these comprise doctoral projects carried out at RAK, often in close collaboration with local and regional industry partners.
- A second phase of EPFL Middle East (continuation until 2020) has been prepared by EPFL and will be formally agreed upon in 2015.

[43] See part D.1 below for further information on Campus Biotech's role in the context of the EPFL strategy in the field of translational medical research.

C.2
Long-term Development

"How can the ETH Domain institutions grow long-term and how can their position be strengthened within the overall academic and economic system in Switzerland?"

C.2 Long-term Development

Assessment by the ETH Board

Assets

The ETH Board is convinced that strengthening the position of the ETH Domain institutions within the overall academic and economic system in Switzerland does not per se require the institutions to grow. In fact, some of the world's leading universities are of similar size to ETH Zurich and EPFL (e.g. Harvard, MIT and Stanford). Rather, qualitative development, driven by the autonomy of the six institutions, is key for maintaining their leading roles. The ETH Board considers that

- the ETH Domain institutions currently hold a *very strong position within the academic and economic system in Switzerland*;
- for academic institutions, growth does not represent an end in itself, but enables them to *prospectively develop new areas of research and teaching, and to set trends in these areas*, while the existing offering remains in demand at the present level;
- the ETH Domain institutions have engaged in continued efforts to join forces with other academic and political actors to *tackle the lack of qualified MINT personnel*, which still represents a pressing need for Switzerland and its economy;
- these efforts are the *main drivers of growth* in the ETH Domain institutions in the recent past.

Challenges and Opportunities

Besides the necessity to *secure the general core prerequisites for any sustainable and successful positioning of the ETH Domain institutions* – i.e. openness and internationality, autonomy, and stable funding –, strengthening the ETH Domain institutions' position within the overall academic and economic system in Switzerland has to meet *four principal challenges*, both on the structural and the topical levels:

a) The ETH Domain institutions must be enabled not only to continue to be flagship institutions of science and technology in Switzerland, but also to continue setting the long-term trends in research and teaching as well as with regard to the planning and development of new research infrastructures. Strengthening the institutions' position therefore means, among other things, strengthening and sustaining their representatives' ability to assume *leading roles in international (scientific) networks*.

b) It is a unique asset of the ETH Domain that it not only provides an excellent environment attracting the best researchers worldwide but also hosts world-leading user labs around large-scale research infrastructures, which serve the international scientific community as well as industry and which prove to be key for the further development of innovation in Switzerland. Strengthening this unique asset of the ETH Domain therefore means *increasing its capacity to contribute to economic development and strengthen existing and new high-tech industries in Switzerland*.

c) Together, the ETH Board institutions must strive at *effectively implementing the strategic focus areas set forth in the ETH Board's Strategic Planning* in order to continuously provide contributions to the important societal challenges, e.g. in the fields of energy and environment, sustainable resource use, or health in an ageing society, and thus further strengthening the ETH Domain's position within society at large.

d) Given the limited nature of resources (both human and financial), the ETH Domain institutions must be *enabled to set posteriorities and to engage in a continuous portfolio*

"How can the ETH Domain institutions grow long-term and how can their position be strengthened within the overall academic and economic system in Switzerland?"

development. The standard practice – applied by all ETH Domain institutions and, in particular, by the Research Institutes – to outsource routine procedures that no longer constitute real research topics, or to hand over such activities to private actors (including spin-offs), must be continued.

C.2.1 Reasons for and Limits to Growth

For academic institutions, growth cannot represent an end in itself. In order to act successfully in research, teaching and knowledge and technology transfer, an institution must reach a critical mass of people involved. However, it should not exceed a size that allows thorough quality control, providing the necessary excellent research infrastructure as well as the required space and capacities for high-level teaching. For all ETH Domain institutions, in their capacity as world-leading universities and research institutes, these requirements define limits of growth, which interact – as a general precondition – with the financial resources attributed to the institutions.

Both the private and the public sector in Switzerland still face a lack of qualified persons in the so-called MINT[44] fields. Both ETH Zurich and EPFL therefore play an important role in meeting the need to train more persons in these disciplines and hence to respond to an urgent requirement of Swiss industry. The two institutions' moderate to rapid (and in any case steady) growth over the past decade is at least partly responsible for the improvement of the situation with regard to MINT personnel. The problem, however, is far from being resolved.

- Between 2000 and 2012 the total number of students (including doctoral students) at EPFL has increased by 90 %.
- For ETH Zurich, the corresponding figure is 66 %.
- In its current outlook, the Federal Office for Statistics is projecting an additional increase of 10 % for both ETH Zurich and EPFL from 2013 to 2020. The two Federal Institutes of Technology therefore expect to reach, by 2020, a total number of 20,000 (ETH Zurich) and 11,000 (EPFL) students.
- Both institutions consider that this represents the limit of size, which they cannot exceed in a long-term perspective. Beyond this size, both institutions estimate that they would not be able to provide the current quality of teaching, learning, and research, and would not dispose of sufficient land reserves, in order to accommodate the teaching and research facilities on their existing campuses.[45]
- In addition, the two Federal Institutes of Technology must be able to control the balance between Swiss and foreign students in order to remain as deeply rooted as today within Swiss society and to maintain the excellent quality of the foreign students admitted to the ETH Domain institutions.

Growth in student numbers is largely driven by the fact that admission to universities in Switzerland is guaranteed for all students having successfully obtained the Matura school-leaving qualification. In order to be able to react to capacity shortages, the ETH Board has been granted, under a 2013 amendment of the ETH Act, the right, if requested by one of the schools, to limit the number of foreign students entering higher-semester Bachelor or entire Master programs. However, no regulation mechanism is in place for the first year of Bachelor programs.

[44] MINT is the German acronym for Mathematics, Informatics, Natural sciences, and Technical sciences. The degrees offered at ETH Zurich and EPFL are predominantly degrees in "MINT disciplines".

[45] Moreover, it is sometimes argued that in general terms the optimum size for a university is between 10,000 and 20,000 students (including doctoral students), which is confirmed by the fact that most top-ranked universities in the world are within this range.

C.2.2 Requirements

As the institutions can be expected to grow until they meet these limits, they also require the means to ensure a student-to-teacher ratio that remains internationally competitive.

- Only if this requirement can be met can the ETH Domain remain attractive for the best students and the best researchers and professors worldwide. As has been shown, this represents a conditio sine qua non for the ETH Domain to exercise its leading role for Switzerland as a science and technology hot spot.
- It is therefore crucial that growth in student numbers is at least matched by an increase in the number of professors both at ETH Zurich and EPFL, and by an increase in the number of senior scientists and teaching assistants.
- This increase must go beyond the mere increase projected in terms of student numbers, as an improvement of the student-to-teacher ratio at the two schools represents a long-standing objective that gains in importance as the expectations towards the institutions rise with regard to both their academic standing and their contributions to the solution of urgent societal needs (such as in the field of energy research).
- At the same time, measures must also be taken to ensure adequate support for all teaching personnel within the institutions.

These considerations apply equally to the increasing involvement of the Research Institutes in teaching at ETH Zurich and EPFL as well as in cantonal universities and Universities of Applied Sciences, and with regard to their increasingly prominent role in the education of doctoral students. For these institutions, however, growth depends less on demographic and economic trends in the number of students. Therefore, drivers of growth and limits to growth are not as clearly defined. The number of tasks assigned to the Research Institutes depends to a considerable extent on government policy and priority-setting, in particular with regard to the research infrastructures they host and operate and to the national tasks they are assigned with. If these tasks, benefiting the scientific community or society as a whole, become more onerous than at present, then it is crucial for policy-makers to ensure that the institutions are granted sufficient resources to successfully handle such new or additional tasks.

In short, the sustainability of growth, as well as the limits to growth, are always going to be shaped in large part by political decisions. Such decisions must ensure

- that adequate means and the necessary degree of freedom are granted to the institutions that are expected to grow; and
- that corresponding measures undertaken by the institutions, e.g. in compliance with the expectation to attract more third-party funds, receive political support.

C.2.3 Novelty

While the institutions of the ETH Domain are convinced that growth must not represent an end in itself, they will, however, encourage growth if this serves the continued effort to enhance the quality and diversity of their work. In this sense, growth may be driven by the fact that new research areas – as was the case, for instance, in the Life Sciences – are developed, while existing ones retain their relevance and cannot be substituted. It may also concern new or enhanced infrastructures and may relate to the geographical dimension and its potential for deepened collaboration.

C.3
Contributions to the Improvement of the Swiss Higher Education System

"In what way do the ETH Domain institutions contribute to improving the Swiss higher education system as a whole? In which areas can they make a greater contribution?"

C.3 Contributions to the Improvement of the Swiss Higher Education System

Assessment by the ETH Board

"In what way do the ETH Domain institutions contribute to improving the Swiss higher education system as a whole? In which areas can they make a greater contribution?"

Assets

Contributions to the improvement of higher education in Switzerland are *provided by all actors in the higher education system, as long as they enjoy sufficient autonomy to focus on their respective scientific strengths.* It is through such a focus that all higher education institutions in Switzerland can represent attractive partners for each other and thus benefit mutually – as experienced in manifold ways by the ETH Domain institutions. The ETH Board is therefore convinced that

- the major contribution of the ETH Domain for the Swiss higher education system consists in the *world-class positioning of its institutions and their academic networks*;
- an important contribution of the ETH Domain at the service of the scientific community in Switzerland and worldwide consists in the fact that *it hosts, operates and develops world-leading, large-scale research infrastructures*;
- the ETH Domain institutions are *pioneering the development of the Swiss higher education system* not least with regard to teaching and the development and training of young academics;
- the excellent positioning of the ETH Domain institutions opens up *unique possibilities for cooperation, education, and teaching* within the Swiss context;
- *cooperation* among ETH Domain institutions and between ETH Domain institutions and academic partners is thus *already very strong*;
- the ETH Domain contributes to the higher education system through the *high-level involvement of its representatives in the SNSF Research Council* and similar scientific bodies;
- such cooperation also comprises *nationwide initiatives* such as SystemsX.ch, Nano-Tera.ch, and other programs plus Cooperation and Innovation Projects of the Swiss University Conference (SUC), as well as the contributions of ETH Domain institutions, often as leading houses, to NCCRs and SCCERs.

Challenges and Opportunities

The ETH Domain institutions and the ETH Board have the ambition to contribute actively and consistently to the improvement of the Swiss higher education system and thereby to strengthen Switzerland's innovative capacity, its leading role and its worldwide reputation in the academic field. Within the context of current developments in higher education policy, the ETH Board highlights the *three following challenges*:

a) Strategic focal points, nationwide initiatives and programs to be defined and implemented by Swiss higher education actors (for instance in the context of the upcoming ERI Message) must be designed in a way that allows *all involved partners to play to their strengths and to contribute their particular competencies in the best possible manner.* From the perspective of the ETH Domain, the Personalized Health initiative and the follow-up of the current Cooperation and Innovation Projects of the Swiss University Conference (SUC) are of particular relevance.

b) With its recent report on measures for the advancement of young academics in Switzerland[46], the Federal Council provides an *important basis for effectively strengthening the Swiss academic promotion system so as to even better enable young academics to pursue an academic career*. However, the ETH Board is convinced that attention must be paid to adequately adapting the intended measures to the individual situation of the respective institutions. For instance, the institutions of the ETH Domain are acknowledged by the report to be pioneers, as they have already implemented the main components of the system, which will now be extended to all Swiss universities – namely, the strategic promotion of assistant professorships with tenure track. Hence the imposition of *adverse or ineffective measures* on them must be avoided.

c) In light of the changes introduced by the new HEdA governance, the ETH Board and the ETH Domain institutions will need to *ensure that they can continue to contribute as effectively as today to the priority-setting and the general decisions governing the development of the Swiss higher education system*. In that way they can fully deploy their strengths to the benefit of the Swiss academic landscape.

C.3.1 Core Contribution: World-class Research

All ETH Domain institutions are characterized by the deeply rooted conviction that only teaching and research which is competitive with other world-leading institutions may yield sustainable benefit for the country (e.g. in terms of highly qualified graduates trained for private and public actors in Switzerland, technological applications at the service of society, jobs created in R&D, etc.). Accordingly, the ETH Board is convinced that their world-class positioning and the dynamic to which this contributes within the Swiss academic community represent their core contribution to the Swiss higher education system. The benefit this generates can be illustrated by the following aspects:

- Given that science and technology clearly represent one of the most important resources on which Switzerland's welfare depends, the fact that both ETH Zurich and EPFL rank among the top universities worldwide and are even leaders in continental Europe[47], is an ever more important element in strengthening Switzerland as a scientific location. Moreover, as shown by the present evaluation, all institutions of the ETH Domain rank well above the world average in terms of bibliometric data.[48]
- Universities and Universities of Applied Science in Switzerland have the opportunity to engage both in competition and in collaboration with world-leading universities within their own country and sometimes even within one geographic area.
- Students – undergraduates and graduates as well as those in continuing education – have the opportunity to learn from the best researchers worldwide from the very beginning and are exposed to stimulating competition in terms of ideas and performance that trains them for their careers in private industry or in academia.

[46] See "Massnahmen zur Förderung des wissenschaftlichen Nachwuchses in der Schweiz. Bericht in Erfüllung des Postulats WBK-SR 12.3343" dated May 26, 2014, http://www.sbfi.admin.ch/themen/hochschulen/index.html?lang=de&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCEdn15gGym162epYbg2c_JjKbNoKSn6A-- (last accessed November 24, 2014).

[47] The leading status of the ETH Domain institutions is not only evident in university rankings, which have always been subject to controversy. It is also confirmed, for instance, by the fact that ETH Zurich and EPFL rank 3rd and 4th with regard to the number of the prestigious ERC grants their researchers have been awarded. On the level of the Research Institutes, several other indicators can be seen as demonstrating their world-leading role in their fields of activity (see the 2013 annual report of the ETH Domain for further details on international benchmarking of the ETH Domain institutions).

[48] See chapter E below for the results of the bibliometric analysis.

– Researchers, both from higher education and research institutions and from the private sector have access to knowledge and world-class infrastructure benefiting their own work; this is evident, for instance, from the fact that during the past years several large and multi-national companies have set up or entirely moved their R&D divisions as close as possible to one of the ETH Domain's institutions.

C.3.2 Pioneering the Development of the Swiss Higher Education System

The general contributions of the ETH Domain institutions to the improvement of the Swiss higher education system outlined above go in parallel with the input that comes from developments in teaching and with regard to organizational issues pioneered by the institutions.

– As, for instance, the recent report of the Federal Council on measures for the advancement of young academics in Switzerland[49] shows, ETH Zurich and EPFL have been pioneers in Switzerland in hiring young professors on assistant professorships with tenure track. In the report, this way of recruiting promising young scholars is presented as one of the most important measures to be more broadly implemented for advancing the position of young academics in Switzerland and hence improving the chances of retaining the best students from Switzerland interested in a scientific career inside or outside Switzerland.

– Similarly, EPFL and ETH Zurich are committed and influential pioneers in the use of online courses for advanced and improved forms of higher education teaching. MOOCs, for instance, not only contribute to new approaches in teaching but also increase the ETH Domain's visibility worldwide.

– ETH Zurich and EPFL have been pioneers in fully implementing the Bologna system within their study programs.

– Not least, all ETH Domain institutions are actively involved in continuing education, where – owing to the outstanding quality of research they offer and to their strong linkages with industry and public administration – they have been able to establish high standards and a strong reputation.

C.3.3 Other Contributions

Other contributions by the institutions include

– the numerous collaboration projects (including teaching at other universities or Universities of Applied Sciences) they are engaged in[50];

– the exchange of best practices with other higher education and research institutions in Switzerland;

– the contributions by ETH Zurich and EPFL to the work of CRUS and swissuniversities;

– the many projects the institutions lead or contribute to in NCCRs, SCCERs and other nation-wide initiatives such as cooperation projects of the SUC;

– the participation of affiliates from institutions of the ETH Domain in recruiting committees, steering boards of academic initiatives and other bodies.

[49] See the Federal Council's report "Massnahmen zur Förderung des wissenschaftlichen Nachwuchses in der Schweiz".
[50] See C.5 below for details on cooperation.

Moreover, a valuable instrument for increasing the linkages and mutual benefit between the institutions of the ETH Domain (in particular the Research Institutes) and the Swiss academic landscape are joint affiliations of professors. This sharing of resources and knowledge on the one hand strengthens the academic profile of the Research Institutes involved while on the other hand it enhances the scientific capacities within the partner institution(s), as they benefit from the outstanding quality of research and teaching provided by the ETH Domain staff. Similarly, mutual benefit is generated through the involvement of PhD students as well as master's students in research performed at the Research Institutes.

C.4
Structure of Study Programs

"Do the Federal Institutes of Technology structure their study programs appropriately for the Swiss higher education system and for Switzerland as an economic and academic center in a globalized world? Do the Federal Institutes of Technology respect the principle of subsidiarity in terms of the training portfolio of the Universities of Applied Sciences and cantonal universities, concentrating on their core mandate?"

C.4 Structure of Study Programs

Assessment by the ETH Board

Assets

ETH Zurich and EPFL develop their study programs to educate students for systemic and interdisciplinary approaches that are rooted in a profound knowledge of fundamental disciplines, and to foster an innovative and entrepreneurial spirit. As the ETH Board holds, it can be shown that

- the study programs at ETH Zurich and EPFL *are very well suited to the requirements of the job market* in Switzerland;
- they are *highly appropriate* to the needs of companies, NGOs and the public administration in Switzerland as well as the Swiss economy as a whole;
- they also allow a sufficient number of students to *qualify for careers on the academic track*;
- the *intense stakeholder involvement* in curriculum development at both ETH Zurich and EPFL as well as in the development of the Research Institutes' continuing education offering is a crucial element in the successful positioning of the ETH Domain's study programs;
- the *principle of subsidiarity* vis-à-vis the partners in the higher education area *is respected*; the teaching and research portfolios as well as their distribution across different academic partners have been adequately reassessed over the past decade;
- a properly functioning system *allows outstanding students from the Universities of Applied Sciences to enter study programs at the ETH* and thus strengthens the permeability of the Swiss dual education system;
- in general, *good use is made of synergies*.

Challenges and Opportunities

The ETH Board holds that *two challenges* need to be addressed with regard to the long-term interaction between different actors in the Swiss higher education system:

a) The ETH Board considers that the Swiss dual education system is crucial to the country's success. It is therefore committed to helping develop the Swiss academic landscape in a way that *strengthens the dual education system, rather than jeopardizing the successful distribution of roles currently in place among the various actors in the Swiss academic system*. The ETH Board will pay particular attention to this view in light of the new HEdA governance.

b) In the ETH Board's view, the principle of subsidiarity means in particular that the ETH Domain institutions must *retain a study program that is primarily based on their fundamental and interdisciplinary research fields. Thus, their profiles must as such remain clearly distinct from the profiles offered by Universities of Applied Sciences*, which educate students primarily based on their mission to cater to the needs of the market. In the long run, this serves, and therefore strengthens, the distinct profiles of each of the higher education institutions in Switzerland. This implies that the *right to award PhD degrees must continue to be granted to the ETH and the universities* exclusively.

"Do the Federal Institutes of Technology structure their study programs appropriately for the Swiss higher education system and for Switzerland as an economic and academic center in a globalized world? Do the Federal Institutes of Technology respect the principle of subsidiarity in terms of the training portfolio of the Universities of Applied Sciences and cantonal universities, concentrating on their core mandate?"

C.4.1 Adequacy of Study Programs

Both Federal Institutes of Technology attach great importance to offering curricula and study programs that serve the prime mission they have been assigned with since their foundation: to train highly qualified experts in the fields of natural and technical sciences including engineering and – more recently – the Life Sciences, and to ensure that they acquire the relevant skills to take up leading positions in industry, in society, or in science. All recent surveys among graduates from ETH Zurich and EPFL confirm that this objective is met to a very high degree. For instance, both MA and PhD graduates enjoy very good employability.[51] Similarly, MINT graduates occupy leading positions to a much larger degree than their peers from other disciplines.[52]

These figures prove the appropriateness of the skills and capacities taught in the ETH Domain and show that the study programs offered successfully answer the needs of the job market. Graduates from ETH Zurich and EPFL seem to be able to meet the requirements of the job market and are well prepared for their careers as leading individuals in private companies or public administration[53]. Both schools place great emphasis on offering an education that ensures excellent employability on the one hand and, on the other hand, gives them the skills and knowledge required by the economic actors in Switzerland and worldwide. Accordingly, quality control of their curricula plays an eminent role at both schools: these processes are regularly evaluated externally (e.g. through audits of OAQ).

C.4.2 Development and Evaluation of Curricula

With regard to *curriculum design*, the evaluation processes are the following:
At ETH Zurich there is a standard process for minor and major changes to curriculum design as well as for the development of a new curriculum:

- The initiative for setting up a new curriculum or for the revision of an existing one can come from the professors or the students.
    - It can be based on own ideas or on good practices of other departments and universities, and on the recommendation of a peer review, of industrial partners or from political circles.
    - The development of curricula lies within the responsibility of a department. Usually, a departmental committee consisting of 1/3 professors, 1/3 senior scientists and assistants, and 1/3 students acts as the driving force.
    - At the central level, the Pro-rector for Curriculum development is delegated by the Rector for managing the process (this function has existed since October 1, 2012). He is supported by the central unit Educational Development and Technology (LET).
    - The LET as well as the teaching specialists in the department support the process, whereas the rectorate is responsible for the legal aspects.
    - Finally, a new curriculum or a revision of an existing curriculum has to be approved by the Executive Board (Schulleitung).
- With respect to major changes of an existing curriculum or the development of a new curriculum, core stakeholders from private industry and public administration as well as the Executive Board are involved at an early stage

[51] See the sources indicated in Footnote 7 (chapter A.1) above.
[52] 24 % for MINT disciplines compared to 16.6 % for other disciplines after one year; almost 50 % after five years for MINT disciplines, compared to about 35 % for other disciplines at the same point in time.
[53] See, e.g., Dyllick, Thomas/Torgler, Daniel (2007): "Bildungshintergrund von Führungskräften und Platzierungsstärke von Universitäten in der Schweiz", in: Die Unternehmung 61 (1), 69-94.

– The Quality Management System of ETH Zurich as a whole has been evaluated by the Swiss Center of Accreditation and Quality Assurance in Higher Education (OAQ) in 2008 and 2013.

At EPFL, the faculty must first present the idea for the introduction of a new curriculum to the EPFL directorate.

– In close collaboration with the Dean of the Bachelor and Master school, the chosen project manager will prepare a detailed analysis according to the official guidelines on how to create a new curriculum.

– The latter require a good knowledge and an overview of existing offers worldwide, an analysis of the strengths of EPFL in the domain at stake, as well as a study of the needs of industry and the future job market, including a forecast of the required infrastructures.

– The complete analysis is finally presented to the EPFL directorate for approval.

Evaluation of curricula is organized along the following lines:
At ETH Zurich curricula are evaluated on the occasion of a peer review by a department, i.e. every 6 to 7 years.

– The process is identical to that of peer review as a whole: The department first produces a self-evaluation report, followed by a site visit by an international review panel. The findings of the other instruments for the evaluation of teaching and learning are considered in both the self-evaluation report and the site visit. These instruments are the course evaluation by the students and the biannual graduate surveys by the Swiss Federal Statistical Office.

– The panel establishes the experts' report, to which the respective department responds in a comprehensive statement.

– The Executive Board of ETH Zurich finally takes its decisions on the basis of the recommendations by the experts and the comments by the department, and submits the report to the ETH Board.

At EPFL, existing curricula are regularly accredited by the Swiss OAQ and the French CTI.

– The Dean of the Bachelor and Master school together with the Deputy to the Vice-president for MQS manages this accreditation.

– For each curriculum there is an advisory board composed of figures from industry as well as external academics which helps the section responsible in reviewing and adapting the general content.

– In each section, an academic committee, including an external member, helps to review the courses as well as examination content.

– In addition, the career center organizes an annual job-ad analysis for every master's title to obtain an indication of the employability of EPFL students.

C.4.3 Stakeholder Involvement

– In all curriculum development processes, it is important that advice from the core stakeholders, i.e. actors from private industry and public administration who represent the occupational fields in which graduates from the corresponding programs may be employed, is integrated in curriculum development. This applies not only to bachelor and master programs but also to the continuing education offering. More precisely, the involvement of private companies is achieved as follows:

- At ETH Zurich, professors are in close contact with industry, usually through research projects. Some of them started their career in industry. At several departments, an advisory board with representatives from industry is assigned the task of ensuring a continuing exchange with industry.
- At EPFL, representatives of the main stakeholders sit on the advisory board of each curriculum. Under the initiative of the Dean of the Bachelor and Master school, a three-month internship was introduced for all engineering students in order to strengthen relations with the job market. Furthermore, EPFL faculty members have close ties with industry through their research and development projects.
- At the Research Institutes, the continuing education offering is being developed and assessed in continuous exchange with relevant stakeholders from the private sector, from professional associations and from public authorities.

C.4.4 Collaboration within Curricula

With regard to the training portfolios of the other higher education institutions, ETH Zurich and EPFL collaborate closely with partner institutions not only within the ETH Domain, but also with universities and Universities of Applied Sciences, mostly within a limited geographical area. Examples are:

- the entire educational offering of ETH Zurich is open to students from the University of Zurich and vice versa (credit points being fully recognized mutually);
- the educational offering of ETH Zurich and the University of Basel in Life Sciences are open to students from both universities;
- in Lausanne, EPFL offers courses in mathematics and in natural sciences for the students of the University of Lausanne;
- at the same time, courses in social sciences and humanities are taught to EPFL students by lecturers from the University of Lausanne;
- the development of the EPFL regional antennae in Neuchâtel, Sion, Geneva and Fribourg will provide new opportunities for collaboration in teaching with Universities of Applied Sciences and academic partner institutions;
- numerous scientists of ETH Domain institutions teach at other higher education and research institutions[54];
- joint master's programs (leading to joint master's degrees) as well as programs in the field of continuing education have been developed and established together with partner universities;
- collaboration with medical schools and (university) hospitals has been significantly increased.

[54] See C.5 below: about 1/3 of all teaching hours of staff of the Research Institutes are taught outside the ETH Domain.

C.5
Cooperation

"How is cooperation between the Federal Institutes of Technology and the Swiss Universities of Applied Sciences and cantonal universities to be judged?"

C.5 Cooperation

Assessment by the ETH Board

Assets

The institutions of the ETH Domain have a *long-standing tradition of collaborating intensively with partners from cantonal universities and from Universities of Applied Sciences*. The ETH Board acknowledges and emphasizes that

- cooperation by the ETH Domain institutions is *far above the cooperation levels achieved by comparable European institutions*;
- cooperation by *ETH Zurich and EPFL is particularly strong with their respective local partner universities* and covers a wide range of fields;
- *cooperation with Universities of Applied Sciences is frequently practiced by all institutions;* this is a particular focus for the Research Institutes, given that their thematic mission places particular emphasis on application-oriented research and continuing education;
- the academic system *sets inherent incentives to collaborate with academic partners worldwide*, as it ensures mutual benefit if collaboration is freely chosen according to the scientific added value it generates for the partners.

Challenges and Opportunities

Given the above-mentioned tendency to a programmatic orientation of research and teaching activities[55] and growing demands for coordination, *three challenges* must be addressed:

a) The ETH Board is convinced that successful academic cooperation at the level of both individuals and institutions is sustainably fostered by *encouraging bottom-up initiatives, rather than by imposing cooperation in a top-down process or as a result of political decisions*.

b) Cooperation between the ETH Domain and the Universities of Applied Sciences can generate considerable added value for both sides. Accordingly, the ETH Board supports initiatives for strengthening this cooperation, but holds that the *distribution of tasks between the ETH Domain and the Universities of Applied Sciences* must be maintained and fostered in order to maximize the mutual benefit of such cooperation.

c) Cost-intensive fields of research and teaching as well as costly infrastructures are areas in which political guidelines and the resulting cooperation are seen as vital to ensuring that resources are efficiently used to the benefit of the entire scientific community in Switzerland. The ETH Board acknowledges the need to ensure a suitable degree of coordination with regard to these cost-intensive fields. However, it feels that the resulting political decisions must fulfill the criteria of scientific excellence and also emphasizes the need to maintain the *fragile balance between competition and cost-effectiveness*.

"How is cooperation between the Federal Institutes of Technology and the Swiss Universities of Applied Sciences and cantonal universities to be judged?"

[55] See chapter B.1 above.

C.5.1 Individual Level

Cooperation among researchers is an indispensable prerequisite for top-level research. Scientific cooperation with like-minded academics, but also with partners outside academia, is necessary to complement existing competencies and, through cooperation, to generate additional scientific knowledge or to find new solutions to practical problems. Hence the institutions of the ETH Domain are all very highly involved in collaboration with other academic institutions, both nationally and internationally:

- For by far the most part, cooperation takes place at the level of individual researchers and research groups.
- Such cooperation takes a wide variety of forms; it may for instance entail student as well as co-worker mobility, the sharing of resources, or joint research and publications. It is therefore impossible to establish a comprehensive overview across the entire range of scientific cooperation.
- Cooperation is not limited to the two ETH but is an equally important component of the research activities deployed by the four Research Institutes.[56] For instance, the PSI currently has more than 1,000 active contracts (collaboration agreements, memoranda of understanding, non-disclosure agreements), of which more than 550 concern Swiss partners. More than two-thirds of the users of the PSI's large-scale facilities are from outside the owner institution.
- Scholars from the Research Institutes are at the same time also highly involved in teaching, not only at ETH Zurich and EPFL, but also at cantonal universities and Universities of Applied Sciences. The number of hours taught by staff members of the Research Institutes amounts to more than 16,000 annually, having stabilized at this level in the recent past. 1/3 of their total teaching hours are taught outside the ETH Domain.

Such cooperation at the individual level generally aims at bringing together the best partners for dealing with a particular scientific issue. Accordingly, scientific added value, gained from a consistent orientation to scientific excellence, is by far the most important und thus the decisive driver for cooperation at this level. Given the global interconnection in all scientific fields, national or regional boundaries are not a prime criterion in the selection of partners.

C.5.2 Institutional Level

- When it comes to inter-institutional cooperation, i.e. cooperation that is formalized by an agreement between institutions, the actors' geographical proximity plays an eminent role. As two recent studies on the Swiss situation regarding inter-institutional cooperation between higher education institutions show,[57] such cooperation cannot be successful if it is conceived as an end in itself. Rather, it is shown that there are three main motives for an institution to engage in formal cooperation with one or several other institution(s) or, not least of all, with private or public actors from industry or public administration:

[56] Joint publications resulting from (individual) research collaborations are an important part of their outcome. The results of the bibliometric analysis conducted for the present evaluation indicate, for each institution of the ETH Domain, the extent to which its publications are the result of international and national collaboration. The analysis shows that international collaboration increasingly represents the standard pattern for publications in (high-ranked) journals, but that national collaboration retains an important role (see chapter E for details).

[57] See Reichert, Sybille (2009): Inter-institutionelle Kooperationen zwischen Hochschulen in der Schweiz: Motivationen, Rahmenbedingungen, Erfolgsfaktoren und Hindernisse. Abschlussbericht der Studie im Auftrag des SWTR, (http://archiv.swir.ch/wp-content/uploads/Abschlussbericht_Studie_SWTR-Kooperation_Hochschulen_Schweiz-2008.pdf [last accessed November 24, 2014]) and Obermayer, Susanne (2011): Kooperationsinititativen an Schweizer Hochschulen, Cahier de l'IDHEAP 262, Lausanne: IDHEAP.

1) The cooperation serves to generate scientific findings that require the specific competencies or resources of the partners involved. In such cases, inter-institutional cooperation is driven by explicit scientific interest and is often the result of bottom-up initiatives from within the institutions.

2) The cooperation is a means of implementing and achieving strategic focal points set by the institutions provided that

   a) specific competencies of the partners involved are indispensable, or
   b) the critical mass of people involved (e.g. researchers, students, infrastructure, patients) can only be achieved by collaborating with other institutions.

   Often, such cooperation helps significantly to make for efficient and effective use of resources and contributes to the national and international reputation of the institutions involved.

3) The cooperation optimizes the educational offering for students, as it links the institutions' academic profiles, provides access to complementary infrastructure, or strengthens inter-disciplinary competencies on each side.

Successful institutional cooperation often requires a large amount of coordination work, particularly as rules and regulations (including the legal framework, which varies according to the type and the ownership of the institution) and institutional cultures differ from one place to another. The institutions of the ETH Domain therefore only engage in inter-institutional cooperation if their benefit, serving at least one of the three major aims cited above, outweighs the efforts required in terms of coordination and controlling.

C.5.3 Extent of Cooperation

All these factors explain why cooperation within the boundaries of a particular type of higher education institutions are much more frequent than cooperation across such boundaries. This pattern applies both to cooperation among universities (including ETH Zurich and EPFL) and among Universities of Applied Sciences.

Furthermore, the factors outlined above also explain why geographical proximity favors the establishment of formal cooperation: not only does it increase the likelihood of mutual knowledge (inspiring bottom-up initiatives), but it also provides intrinsic incentives to engage in joint portfolio development, particularly in teaching, and to create joint institutes and centers of excellence as well as dual professorships (Doppelprofessuren, of which there are 33 at ETH Zurich and 19 at EPFL). The latter are a particularly strong form of formalized cooperation permitting an optimized use of resources and the pooling of particular strengths of the partners involved to generate mutual benefit.

It has been shown that, on an international comparison, Swiss academic institutions cooperate to a particularly high degree and that this cooperation is, to a very large extent, voluntary.

For example, the above-mentioned study on the Swiss situation regarding inter-institutional cooperation between higher education institutions shows that, compared to other European countries, Swiss institutions have engaged to a unique extent in processes of joint portfolio development without external pressure.[58] As the study argues, the density of corres-ponding cooperation between ETH Zurich and the Universities of Zurich and (to a lesser extent) Basel in German-speaking Switzerland and between EPFL and the Universities of Lausanne (and, in some cases, Geneva) in the French-speaking region are outstanding examples of the particularly high level of cooperation practiced by Swiss academic institutions.

[58] See Reichert 2009, 10.

In the meantime, the institutions of the ETH Domain have further increased their efforts in the field of cooperation. Examples are:

- "Hochschulmedizin Zürich" involving ETH Zurich, the University of Zurich, and leading hospitals in Zurich[59] (as just one example among many other cooperation initiatives in Zurich);
- ETH Zurich's cooperation with the University of Basel, particularly in the field of Biosystems Science (D-BSSE);
- ETH Zurich's cooperation with the *Università della Svizzera Italiana* (USI) as well as with the Institute for Biomedical Research (IRB) in Bellinzona;
- the Campus Biotech at Geneva with the University of Geneva and Hôpitaux Universitaires de Genève;
- EPFL Valais Wallis with the HES Valais and the EPFL antenna at Fribourg with the University of Fribourg and HES Fribourg;
- the jointly financed professorships established between Research Institutes and ETH Zurich or EPFL and between the Research Institutes and cantonal universities.

All these examples testify to the ETH Domain institutions' close involvement in partnerships and collaborations that benefit the respective regions and Switzerland as a whole and that strengthen the institutions' academic profiles and reputation on a national and an international scale.[60] Further examples, some of which also lead to an increased exchange with Universities of Applied Sciences are: the competence centers of the ETH Domain, the Swiss Competence Centers in Energy Research (SCCER), which are in most cases led by ETH Domain institutions (including Research Institutes in two cases), the National Competence Centers of Research (NCCR), the cooperation projects funded by the Swiss University Conference (SUC); another example is the central role assumed by the ETH Domain institutions in the creation of a Swiss Innovation Park[61].

[59] See part D.1.1 below on "Hochschulmedizin Zürich".
[60] See part C.1 above for further information on regional branches of ETH Domain institutions and the inter-institutional cooperation resulting from the institutions' presence in the different regions of Switzerland.
[61] See part A.3 above for information about the ETH Domain institutions' role in the creation of the Swiss Innovation Park.

D
Medical Science and Medical Technology

D
Medical Science and Medical Technology

Introduction

The medical technology industry plays an ever more important role in Switzerland. Thus in 2011, 1,600 Swiss medical technology companies employed approx. 51,000 people. These companies generate more than 2 % of Switzerland's gross national product.[62] Medtech companies are responsible for more than 5 % of total Swiss exports. In certain parts of the country the growth of the medical technology industry has been particularly marked, for instance in the Lake Geneva and Zurich areas; in both cases this can be attributed in large part to the strong university presence, including that of the ETH Domain institutions.

The institutions of the ETH Domain and their researchers are involved in a wide range of technological developments which potentially facilitate or enhance prognosis, diagnosis and treatment in various therapeutic fields:

- These include bioimplants, radiopharmacy, proton therapy, minimally invasive monitoring and surgical procedures, high-resolution MRI and other imaging technologies, the specific targeting of cancer cells with nanoparticles, thought-controlled prosthetics, neuroprostheses for loss of hearing, sight or motor function, the biotechnological production of vaccines, and intelligent drug delivery systems.
- What all these examples have in common is that they require close cooperation between basic research, on the one hand, and clinics or clinical research, on the other hand, for real breakthroughs to be achieved.
- They thus demonstrate the importance of *translational medical research* and therefore also basic research in natural sciences and technology for the advancement of knowledge and for fostering the development of advanced (or high-tech) prognostic, diagnostic and therapeutic approaches of forward-looking medicine in Switzerland.
- To be able to master healthcare challenges, Switzerland not only needs highly qualified medical specialists but also researchers with specialist knowledge of specific fields such as statistics, information technology, engineering sciences, imaging or genetics. With a view to the future development of university medicine in Switzerland, the institutions of the ETH Domain therefore see their priority role in this area. The integration of key technologies such as microsystems and nanosystems, material sciences, communication and information technology, mechanics, electronics and robotics in research and development is increasingly becoming indispensable.
- The ETH Board is convinced that, besides research, the integration of such technologies in existing, research-related curricula, the creation of new facilities for teaching and training, and a linkage between curricula in natural and engineering sciences with medicine, constitute the cornerstones for innovation in the health sector. Accordingly, the two Federal Institutes of Technology offer high-quality and future-oriented curricula at the interface between natural and engineering sciences, on the one hand, and medicine, on the other hand, in order to educate specialists for Swiss industry and for academic and industrial research.

[62] Cf. Swiss Medtech Report 2012, medtech Switzerland, Berne, http://www.medtech-switzerland.com/en/index.php?section=downloads&cmd=11_tree&download=1 (last accessed: November 24, 2014).

D.1
Strategy in Medical Science and Technology

"What assessment can be made of the ETH Domain's strategy of boosting translational research and teaching and Switzerland's innovative strength in the areas of medical science and medical technology?"

D.1 Strategy in Medical Science and Technology

Assessment by the ETH Board

Assets

With regard to (bio-)medical research and medical technology, *the ETH Domain already plays an important part in the Swiss university and healthcare systems* and in their reinforcement and development. In support of this claim, the ETH Board underlines that the ETH Domain

- *provides excellence in research and education* in the highly specialized fields of biotechnology, engineering sciences, and life and health sciences, both with regard to Switzerland and worldwide;
- places a strong focus on the generation of knowledge and the promotion of innovation and entrepreneurship, with a *particular impact on the field of medical technology*;
- educates and trains future experts for *academic and industrial clinical research*;
- is a consistent driving force in the *creation of new research and technology platforms and in the development of existing ones*, notably in the field of translational medical research, where the Swiss TransMed program of the CUS has been initiated by the ETH Domain;
- is engaged in an *intensive exchange of scientific knowledge and cultivates sustainable partnerships* with researchers from other universities and with (university) hospitals all over Switzerland, which, in turn, are able to benefit directly from the know-how they receive from the ETH Domain;
- possesses, with the *Center for Proton Therapy at PSI, a medical infrastructure – unique in Switzerland – for the treatment of patients* and for the further clinical and technological advancement of these therapies, with a corresponding political mandate granted by the 'Beschlussorgan der Interkantonalen Vereinbarung über die hochspezialisierte Medizin' (decision-making body established under the intercantonal agreement on highly specialized medicine).

Challenges and Opportunities

The ETH Board, therefore, is convinced that the ETH Domain's strategy in the field of translational (bio-)medical research will yield significant impact. However, *two challenges* need to be addressed:

a) The *future settings in which translational medical research will be promoted in Switzerland and the corresponding research priorities are currently being defined by the responsible bodies, with the ETH Domain institutions and the ETH Board playing an active role.* The decisions to be taken include political decisions on the federal level and among the cantons. In the Personalized Health initiative, in which the ETH Domain plays an important conceptual role, institutions of the ETH Domain will make major contributions and assume leadership in their areas of competence. *The ETH Board confirms its willingness to attribute an active and important role to the ETH Domain institutions in this regard.*

b) In view of the growing demand for technically skilled academic personnel in the increasingly technology-driven environment of clinical medicine and translational research, the *role of the ETH Domain in educating medical scientists in the future* needs to be redefined in order to fully exploit its competencies in this area.

"What assessment can be made of the ETH Domain's strategy of boosting translational research and teaching and Switzerland's innovative strength in the areas of medical science and medical technology?"

The institutions of the ETH Domain, notably the two Federal Institutes of Technology and the PSI, have long been engaged in the field of medical research and the development of medical technology in a wide variety of ways. Translational medical research, in contrast, represents a more recent focus. From a strategic point of view, the ETH Domain institutions accord particular importance to the reinforcement of translational research in medicine and have set their own priorities in this area. This is documented, for instance, by the fact that the ETH Domain institutions (proposed by ETH Zurich, EPFL and the PSI jointly) will implement a Personalized Medicine and Medical Technology strategic focus area formulated in the ETH Board's Strategic Planning 2017–2020 document. In view of their contribution to the development of university medicine in Switzerland, ETH Zurich and EPFL noted in 2011: "Today, Switzerland lacks medical doctors who are sufficiently proficient in research to develop translational research. The ETH strategy intends to redress this deficiency by teaching medical doctors the necessary scientific fundamentals and by creating translational platforms on which the transfer of knowledge can be carried to the actual patients."[63]

To attain this objective, the ETH Domain institutions estimate that added value can be best generated by intensifying formalized collaboration between the institutions of the ETH Domain, cantonal universities and (university) hospitals. Therefore, they have actively contributed to the conception of the planned national Personalized Health initiative. The actual focus of this nationwide collaboration as well as the related priorities and distribution of tasks are currently still under development. Therefore, the role which the ETH Domain institutions will occupy in the corresponding networks is yet to be defined in detail and also hinges on policy decisions to be taken among the actors involved. However, both the ETH Domain institutions and the ETH Board have repeatedly declared that they are willing to assume a leading role in strengthening translational medical research and medical technology in Switzerland.

This chapter (D.1) presents an overview of existing and upcoming initiatives, projects, infrastructure, curricula, and additional activities pursued by the ETH Domain institutions in the fields of translational medical research and in medical technology. They outline the experience gained in the ETH Domain and the contributions the ETH Domain institutions can make to further develop these fields. The next chapter (D.2) will deal with the area of teaching and education, particularly with regard to the issue of the growing shortage of medical specialists.

D.1.1 Translational Medical Research

In the future, the translation of innovative concepts from basic research into clinical practice will increasingly be the responsibility of the universities. University centers for medical research are privileged locations facilitating a transfer from research in the lab to the individual patient ("from bench to bedside"). In order to meet this challenge, the institutions of the ETH Domain estimate that certain prerequisites for successful translational medical research and teaching must be guaranteed. These are primarily the following:

1. enabling of interdisciplinary research and teaching within the school,
2. proximity of (university) hospitals, cutting-edge research and research-oriented, interdisciplinary study programs, and
3. intensification of collaboration with the medtech industry.

Both EPFL and ETH Zurich as well as PSI and Empa have created and can rely on a setting in which these conditions are met. They benefit from their proximity to excellent hospitals, notably

[63] Aebischer, Patrick/Eichler, Ralph/Escher, Gérard/Leuthold, Margrit (2011): "Die Strategie der beiden ETHs im Bereich der Medizin", in: SAMW-Bulletin 4/2011, p. 4 (http://www.samw.ch/dms/de/Publikationen/Bulletins/11-4_SAMWbulletin_D.pdf, last accessed: November 24, 2014).

UniversitätsSpital Zurich, Universitätsklinik Balgrist, the Psychiatrische Universitätsklinik, the Children's Hospital Zurich as well as the Schulthess and Hirslanden clinics for ETH Zurich, CHUV (Lausanne) and HUG (Geneva) for EPFL, and the Children's Hospital Zurich, UniversitätsSpital Zurich, CHUV (Lausanne) and Inselspital Berne for the PSI. At the same time, they have close ties with the pharmaceutical industry and are linked in various ways with the MedTech and Biotech industry.

Accordingly, for efficient translational research and transfer of knowledge and know-how, engineers and scientists must be in direct contact with the clinical setting (even during surgery). These "under one roof" operations are still underdeveloped in Switzerland, but the ETH Domain is investing considerably in creating them. The following projects and initiatives can be cited as examples:

Centers, Initiatives and Platforms: Existing and under Development

- Hochschulmedizin Zürich:
  - Hochschulmedizin Zürich was set up in 2012 as a strategic initiative of the University of Zurich, Zurich University Hospital and ETH Zurich and was conceptualized as an umbrella organization that subsumes all research activities in biomedicine and medical technology and in teaching, thus constituting a formal basis for the linkage between medicine and basic research. The other four university hospitals in Zurich were admitted in November 2014.
  - Among others, the "Zurich heart project", the Zurich Neuroscience Center and the Regenerative Medicine and Infection and Immunity networks come under the Hochschulmedizin Zürich umbrella.
  - At present, ETH Zurich and Zurich University jointly run two institutes relevant to medical fields of research: the Institute for Biomedical Engineering (since 1971) and the Institute of Neuroinformatics (since 1995) which both are part of the Department of Information Technology and Electrical Engineering at ETH Zurich. Currently, 17 joint professors in medicine-related fields work at both ETH Zurich and the Medical Faculty or the Faculty of Science of Zurich University.
  - The jointly run Competence Centers and technology platforms relevant to medicine – some of them with their own doctoral programs – are the Center for Imaging Science and Technology (CIMST) and its successor EXperimental & Clinical Imaging TEchnologies Zürich (EXCITE Zürich, from 2014), the Functional Genomics Center Zurich (FGCZ), the Zurich Neuroscience Center (ZNZ) and the Center for Personalized Medicine, which is currently in the launch phase. These initiatives will now be run under the umbrella of Hochschulmedizin Zürich.

- Geneva Biotech Campus:
  - At its newly acquired Geneva Campus, EPFL has launched an initiative that will play a leading role in translational medical research. In 2013, EPFL – together with the University of Geneva and the University Medical Hospital (HUG) – secured a long-term rental agreement for the former Merck-Serono headquarters in Geneva. 40,000 m² are thus at disposal for its new initiative. While this was still being established, EPFL was able to secure a 100 MCHF gift from H.-J. Wyss, four chairs sponsored by E. Bertarelli and one by Medtronics to develop new therapeutic approaches to neurological and psychiatric diseases.

  - Campus Biotech will host the EPFL Center for Neuroprostheses, the Wyss Centre for Neuroengineering, the Human Brain Project, and the Geneva University Institute for Affective Diseases. Close to 800 researchers will work in the new campus in close interaction with start-ups and companies to develop novel approaches to brain disorders.
  - Geneva Biotech Campus will also host a translational research program in personalized medicine, integrating big data and public health and clinical approaches within a Lemanic Center for Personalized Health.

- Wyss Translational Center Zurich:
  - In December 2014, ETH Zurich and the University of Zurich have announced the founding of a new translational research center at the interface of medicine, science and engineering: the Wyss Translational Center Zurich (WTZ). A USD 120 million donation from H.-J. Wyss to the two Zurich universities will allow them to build up a new centre that aims, through an interdisciplinary approach, to accelerate the development and application of innovative medical therapies and groundbreaking robotic systems.
  - The USD 120 million donation is a basic endowment to establish and operate the WTZ for the first seven years. ETH Zurich and UZH will provide personnel and infrastructure in the new center.
  - The WTZ will initially include two technology platforms – one for regenerative medicine and the other for robotics. The centre will bridge disciplinary and institutional barriers and unite researchers across various disciplines, ranging from technology and medicine through to materials science, stem cell research and robotics.
  - On the basis of the two translational technology platforms – regenerative medicine and robotics – the WTZ will commence operations in 2015 with a starting portfolio of four translational projects: Zurich Life Matrix, Zurich Heart/Ventricular Assist Devices, Zurich Liver and Zurich Eye.

- Swiss Cancer Center Lausanne:
  - EPFL also plays a key role in the future Swiss Cancer Centre Lausanne, located at the Lausanne University Hospital (CHUV) campus. This center is jointly operated by CHUV, the University of Lausanne, EPFL, the Ludwig Center, and the ISREC Foundation. Its ambition is to bring together scientists and practitioners under one roof as part of a community of expertise to foster translational research in oncology. A new dedicated building located next to the CHUV, named Agora, will be able to accommodate 400 researchers and clinicians in premises occupying 11,500 m^2 as early as 2016.

Further Focal Points

- Biomedical Engineering:
  - At ETH Zurich, the Institute of Biomedical Engineering offers a specialized master's program in Biomedical Engineering. A specialization in Medical Technology will be established jointly at the Medical Faculty of the University of Zurich and the Department of Health Sciences and Technology (D-HEST) of ETH Zurich; it will serve to educate specialists at the interface between medicine, technology and natural sciences. The PSI is actively involved in this program, especially in the Medical Physics track and in the ETH Zurich Master of Advanced Studies in Medical Physics.

  - Within EPFL's School of Life Sciences, the Doctoral Program in Biotechnology and Bio-engineering (EDBB) provides doctoral students with the education necessary to be leaders in the fast-growing industrial and academic biotechnology and bioengineering sectors. EPFL also proposes an advanced course, the Certificate of Advanced Studies in Management of Biotech, Medtech and Pharma Ventures.

- Life Sciences:
  - At both Federal Institutes of Technology, the units specifically located in the fields of health and life sciences, as well as the curricula they teach, are of central significance for the implementation of the strategy for translational research in medicine.
  - At ETH Zurich, the Department of Health Sciences and Technology (D-HEST) was established in early 2012. It supplements the Institute of Biomedical Engineering (founded in 1971, see above) as well as other areas of medical focus already in place, such as the Molecular Health Science Platform in the Biology Department. The purpose of D-HEST is to unite the engineering sciences, life sciences and medical sciences, to promote interdisciplinary research projects at these interfaces, and to offer interdisciplinary curricula.
  - At EPFL, the School of Life Sciences was founded in 2002, and the Institute of Bioengineering (a joint operation of the School of Life Sciences and the School of Engineering) in 2003. The growth of the School and the Institute these past ten years reflects the priority accorded by EPFL to biomedical research, but also reflects the ever-growing interest in these disciplines with regard to both research and education.

National initiatives: ETH Domain contributions

At the national level, ETH Zurich and EPFL, as well as PSI and Empa are heavily involved in two national programs aiming at developing translational interdisciplinary research, from fundamental basic research to the bedside:

- SystemsX.ch, active since 2004, is a Swiss flagship project in systems science. ETH Zurich (with its Department of Biosystems Science and Engineering in Basel) is leading the project, with extensive participation of EPFL and other ETH Domain institutions. This program will evolve to become the leading research enterprise in personalized medicine, at the junction of clinical practice, big data, e-health and the "omics revolution" led by individualized genomic analysis and treatments. ETH Zurich and EPFL – notably thanks to their know-how in mathematics, informatics and genomics – aspire to be designated as leaders in this new phase, together with participating university hospitals.
- Nano-Tera, active since 2004 is another Swiss flagship project in nanotechnology. EPFL is leading the project, with extensive participation of ETH Zurich and other ETH Domain institutions. Lately, Nano-Tera has made significant inroads in medical technology, with smart implants for orthopedics surgery and the LiveSense cell-based sensing microsystem, a tiny, portable personal blood testing laboratory.
- To strengthen clinical research and translation in Switzerland, ETH Zurich and EPFL, together with the cantonal universities and the university hospitals, launched the SwissTransMed project, which in the 2013-2016 planning period is being funded by the SUC and the ETH Board. SwissTransMed funded six translational research platforms run in tandem by an ETH Domain lab and a Medical Faculty/University Hospital lab.

D.1.2 Medical Technology

In the field of medical science and technology, the significant number of medtech spin-offs from the ETH Domain as well as the specific contributions of the PSI deserve particular attention.

MedTech Spin-offs

Many spin-off companies related to the ETH Domain are active in the field of medical technology. This testifies to the ETH Domain's strong position in the advancement of medical technology in Switzerland (and in strengthening Switzerland as a prominent location for medtech innovation). Since 2008, for instance, 22 start-ups have been created in this field by ETH Zurich. Likewise, the majority of the total of 18 EPFL medtech start-ups have been created since 2008. These start-ups operate in diverse fields ranging from diagnostics and imaging (e.g. blood analysis, cancer identification and allergy detection), to surgery and tools (precision robots, deep brain stimulation, endoscopy, virtual reality), and therapy (new agents in immune system stimulation, nanovectors to deliver drugs).

The Center for Proton Therapy at the PSI

With its specialized infrastructure and competencies in diagnostic and therapeutic technologies, the PSI makes a significant contribution to research and KTT in medical technology. A strong linkage between the PSI as a research institution, university hospitals and industry plays an essential role here: whereas the large-scale research facilities improve the fundamental understanding of structure-response relationships, subsequent developments (pharmaceutical active substances, new irradiation facilities etc.) are performed by industrial partners, and these products are then tested in clinical trials together with university hospitals.

The PSI's activities in diagnostics and therapy cover the entire range from fundamental research to medical applications: Most notably, its Center for Proton Therapy (CPT) is the only place in Switzerland where patients with specific types of cancer (e.g. eye tumors) are treated with protons:

- The PSI was the first facility worldwide to develop spot scanning for proton therapy and it currently operates two gantries for the treatment of deep-seated tumors.
- Spot scanning technology is now widely recognized as the state-of-the-art technology preferred both by industry and hospitals.
- Due to a joint academic affiliation, the PSI's links to the university Hospitals in Bern and Zurich are being strengthened and clinical research at PSI will be intensified.
- A third treatment room, Gantry 3, will be realized by 2016 in close collaboration between the University Hospital in Zurich and the PSI together with Varian Medical Systems. It will permit the treatment of moving targets.
- In addition to the treatment of deep-seated tumors, almost 6,000 patients with eye tumors have been treated at the PSI OPTIS facility since 1984 in close cooperation with the Hôpital Ophtalmique Jules Gonin at the University of Lausanne.
- The CPT provides an example of the benefit to society of top-notch research infrastructure that is still under scientific development and of a treatment facility located directly at a research institution (translation). This would be impossible in a clinical setting.

Further PSI Involvement

- The PSI hosts the Biomolecular Research Laboratory (BMR), where proteins are investigated from different perspectives. BMR is actively involved in the Cancer Network Zürich (CNZ) under the umbrella of Hochschulmedizin Zürich (HMZ).
- The Center of Radiopharmaceutical Sciences (CRS) is a joint endeavor between ETH Zurich, the PSI and the University Hospital Zürich. It works on clinical applications of radiopharma-

ceuticals based on an interdisciplinary approach involving radiopharmaceutical chemistry, biochemistry, molecular biology, pharmacy, and pharmacology. The main focus is on the development of functional radiopharmaceuticals, which can serve both as diagnostic agents in nuclear medicine and as therapeutic agents for use against tumor metastases, in particular of disseminated tumors that cannot be removed surgically or treated by external radiation therapy.

D.1.3 Cost-Intensive Research Infrastructures

The role universities will increasingly play in the field of translational medical research also involves making cost-intensive research infrastructures available to medical research. This includes clean-room infrastructures, electron microscopy centers at ETH Zurich and EPFL, and ETH Zurich's Swiss National Supercomputing Center (CSCS) in Lugano, which also hosts the computing infrastructure of the Human Brain Project.

With its Swiss Light Source (SLS), the PSI has a facility which provides unique possibilities for structural biology, e.g. the investigation of proteins, DNA, and RNA, which is presently performed in close collaboration with the pharmaceutical industry and which creates the basis for structural-based drug development. In the near future these capabilities will be further complemented and extended by the availability of the SwissFEL facility.

D.2
Contribution to the Alleviation of Shortage of Medical Staff

"How can the ETH Domain contribute to alleviating the shortage of medical staff in Switzerland?"

D.2 Contribution to the Alleviation of Shortage of Medical Staff

Assessment by the ETH Board

"How can the ETH Domain contribute to alleviating the shortage of medical staff in Switzerland?"

Assets

The ETH Board *attaches great importance to the discussion about its possible contribution to the alleviation of the shortage of medical staff* in Switzerland. In the Board's opinion,

- the primary focus of educational measures currently taken by the ETH Domain is the education of medical scientists[64] and research personnel with a strong background in natural and engineering science, which will have an *impact on building up additional competencies on the clinical side and on clinical studies in the medical technology field*;
- the ETH Domain's possible contribution to the alleviation of the shortage of medical staff would have to be the *object of detailed discussions at the competent political and university policy levels*;
- it must be borne in mind that the *institutions of the ETH Domain offer and could expand corresponding measures* (for instance expanding crossover options between curricula in natural sciences and the master's program in medicine).

Challenges and Opportunities

Given that measures taken against the shortage of medical staff need coordinated action on all political levels, the ETH Board holds that *two challenges* must be carefully considered:

a) The ETH Board pursues the strategic objective to *strengthen existing collaborations of ETH Domain institutions in the fields of biomedical research and medical technology and to further develop cooperation in these areas*. In contrast, the ETH Board has no strategic aims to strive towards the creation of a medical school within the ETH Domain.

b) Any possible contribution of the ETH Domain institutions to the alleviation of the staff shortage must be *viewed in the context of the general conditions with which personnel in the health sector are confronted* and will not help in solving certain systemic shortcomings. In particular, this concerns the workload of medical staff, which also impacts on the time medical doctors can spend for research and training of MD or PhD students. In addition, it relates to the general conditions for medical doctors with families, which result in a large number of highly educated personnel withdrawing from medical service. With regard to adapting any policy to address the shortage of medical personnel, the ETH Board suggests that this point of departure must be taken into consideration.

[64] In what follows, the term "medical scientist" will be used to designate those medical doctors who will be trained in a specifically research-oriented way in order to be able to act as key drivers for strengthening the clinical capacities in translational medical research.

D.2.1 Educational Efforts

In terms of the possible contributions that the institutions of the ETH Domain can make to alleviate the shortage of medical staff in Switzerland, the focus is on their activities with regard to teaching and training medical personnel. In their "Strategy in the field of medicine" of 2011, the institutions of the ETH Domain stipulated two objectives: for one thing, a sound scientific and technological basis should be safeguarded for such medical doctors who would want to specialize in highly technologized supply areas such as radio-oncology, genetics or regenerative medicine; for another, a number of research-oriented medical doctors should be educated who should be in a position to develop translational research and thus bridge the gaps between research and clinics.[65] According to the strategy, this course of action aims to specifically educate a limited number of medical doctors for the purpose of translational medical research. The ETH Domain institutions are of the opinion that in the overall context of the health sector, these medical scientists would constitute an indispensable complement to their traditionally educated colleagues. The institutions emphasize in this context that this objective must not compete with other high-priority goals in the health sector, for instance the necessary increase in the education of general medical practitioners.

"Passerelles"
One solution to ensure a solid technological knowledge for MDs specializing in high-tech domains is to give highly talented EPFL and ETH Zurich students the option of entering a medical school.

- Such "passerelles" are extensively addressed by the Medical Strategy of the ETH Domain. The University of Lausanne, for instance, has set up a program since 2012 to accept – upon selection (i.e. on the basis of a personal dossier) – EPFL students with a bachelor's degree in life sciences, who directly enter the first year master's course in medicine. These students with a strong background in mathematics, informatics and genomics are intended to provide the "high-tech MDs" necessary to our health system. A similar passerelle has now been set up with the University of Geneva, where again students that are accepted can pass from the EPFL bachelor's degree to a first-year master's course in medicine.
- In Zurich, students with a good bachelor's degree in Health Sciences and Technology (HST) or biology and who have passed an aptitude test have for many years been able on request to join the second year of medical studies at the University of Zurich. This crossover involves a great deal of work and is only chosen by a few students. In turn, medical students are admitted to ETH Zurich sur dossier. In any case, the numbers of students making use of the crossover systems at both Federal Institutes of Technology are small and do not compete with other urgent needs, especially the need to educate more general practitioners in Switzerland.

Further Initiatives
Likewise, both ETH Zurich and EPFL have been actively engaged in the education of MD-PhD candidates since the creation of the program in 1992. The MD-PhD is a doctoral program in natural science that can be completed on the basis of medical studies in research. Many of these candidates conduct their research work at either of the two Federal Institutes of Technology – mostly in biological sciences – and thus benefit from their excellent general conditions and courses.

In the field of teaching, programs in the areas of health and life sciences are offered by ETH Zurich and EPFL in which health sector specialists are trained. For instance, at ETH Zurich's D-HEST, a study program in Health Sciences and Technology (HST) was introduced in autumn

[65] Cf. "Die Strategie der beiden ETHs im Bereich der Medizin", p. 3.

2011. This program is very popular, attracting 230–260 new students every year. In addition to conveying natural and engineering science subject matter, the program introduces undergraduates to specific core areas of medicine such as anatomy and physiology and brings them into contact with patients and medical doctors. In ETH Zurich's opinion, this degree would enable students to cross over to a master's program in medicine with only a few additional requirements to be satisfied.

D.2.2 The ETH Domain's Possible Role to Alleviate Staff Shortage

From the point of view of the ETH Domain institutions it must be underlined that the proprietary curricula of the two Federal Institutes of Technology, the MD–PhD program and the passerelles must not and cannot be seen as ways of solving the shortage of medical staff in Switzerland. Although the MD–PhD program and the ETH Domain's intention to specifically educate some medical scientists in the activities of translational research for the purpose of reinforcing the latter do indeed aim to attract a few medical doctors to research, this is done with a view to strengthening the whole of Switzerland's healthcare system in the long term.

In the view of the ETH Domain institutions, one effective contribution could consist in putting the crossover options between curricula in natural science and the master's program in medicine to better use. The institutions of the ETH Domain already stated their ideas in this respect in the above-mentioned strategy for the field of medicine by saying that the crossover at the master's level (i.e. students joining the master's program in medicine after obtaining their bachelor's degree from ETH Zurich or EPFL) would be their preference. The institutions of the ETH Domain feel that such improved crossover options would also make more effective use of the existing educational capacities.

A prerequisite for this is, however, to diversify the Medical Education Track. This would need to be done by consistently applying the "Bologna approach", i.e. the division of medical studies into bachelor's and master's degrees, as, for instance, already implemented by the University of Zurich. Although Switzerland has officially adopted this system, the diversification of medical bachelors and masters has not yet occurred. With their existing curricula, or with curricula to be developed, the two Federal Institutes of Technology are able to educate students who qualify for a crossover to the master's program in medicine. In this way, they may help directly to alleviate the shortage of medical staff, provided that the corresponding capacities in medical master programs are available.

E
Bibliometric Analysis

E
Bibliometric Analysis

E.1 Background and methodology

As requested by the performance mandate, the ETH Board has commissioned a bibliometric analysis on the ETH Domain in view of the present intermediate evaluation. As in the previous cases and for the third time in a row, the analysis has been carried out by the Center for Science and Technology Studies (CWTS) at Leiden University, The Netherlands. While the first analysis, linked to the intermediate evaluation of 2006, has covered the period 1994–2003, the second bibliometric study, elaborated for the intermediate evaluation 2010, has analyzed publications of the years 2000–2009. The present analysis covers the years 2003–2012, with citations up to 2013. It seeks to present comprehensive and up-to-date results regarding the scientific output and impact of the ETH Domain institutions, while allowing for comparison with the previous report despite methodological changes and improved indicators.

CWTS' methodology offers a variety of indicators, destined at measuring the scientific output of a particular institution as well as the impact of the publications it produces. The output indicator shows the number of an institution's publications, with only articles, reviews and letters (with a weighting of 0.25, given the smaller scientific contribution they represent) taken into account for all the indicators used in the present study. Output is an important indicator to evaluate an institution's quantitative performance, but does not allow assessment of the scientific quality of the institution's contributions. This is the function of impact indicators, which are therefore of greatest interest in the context of the present evaluation. Impact indicators are all based on the concept of counting the number of times the publications of a unit have been cited. For this bibliometric analysis, citations received up to 2013 have been counted. Impact indicators, however, disregard self-citations, in order to reduce the potential for 'manipulation' of the indicator by the individual researchers. The four relevant impact indicators[66] on which the current analysis focuses are the "Mean Citation Score (MCS)"[67],

[66] Source: Bibliometric Evaluation by CWTS on the ETH Domain institutions (2014).

[67] The MCS is the most basic impact indicator used by CWTS. It shows the average number of citations a particular publication has received. This indicator, however, does not allow for comparison between scientific fields, as these fields present very different citation characteristics. For instance, the average number of citations an article in mathematics receives within a three-year period equals 2.0, whereas an article in cell biology will receive 19.6 citations on average within the same time period.

the "Mean Normalized Citation Score (MNCS)"[68], the "Mean Normalized Journal Score (MNJS)"[69], and the indicator referred to as "PP(top 10 %)"[70].

Besides the output and impact indicators, CWTS also assesses scientific co-operation patterns. The scientific co-operation indicators distinguish between publications produced by a single institution (no collaboration), publications produced within the same country (national collaboration) and publications produced by institutions from different countries (international collaboration). These co-operation indicators underscore the growing importance of scientific co-operation, in particular in terms of international collaboration, as related to the impact of a publication (whether or not this resulted from collaboration).

E.2 Results

- On the one hand, the bibliometric analysis performed by CWTS depicts the individual research profile for every institution. On the other hand, it makes it possible to assess both the institutions' publication output as well as the impact of these publications. By using the indicators described above, it also permits assessment of the evolution of both output and impact over time.
- Both with regard to the publication output of the institutions and to the impact of these publications, the comparison between the evaluation periods shows a continuous increase for all ETH Domain institutions. All impact indicators show that the scientific importance of research performed at the ETH Domain institutions remained above the world average in almost all fields considered and has also even grown in fields in which it was shown as being very high by the previous evaluation. As an overall statement, therefore, the CWTS evaluation confirms the very high level of the scientific work produced by the ETH Domain institutions and the steady increase in their performance as presented by the ETH Board and the institutions in their annual reports.
- Using the MNCS indicator, CWTS also presents a so-called knowledge user analysis for each of the institutions. A knowledge user analysis can help to explore the subsequent impact the publications of a unit have had on other fields and units (i.e. if the citing publications have themselves a high impact level). The knowledge user analyses provided by the current CWTS report strongly support the general picture regarding the quality of the ETH Domain institutions' work and their international standing: Publications produced by ETH Domain institutions clearly have worldwide impact and in most cases contribute, among the partners

[68] To better depict the quality of an institution's scientific contributions, CWTS has developed two normalized impact indicators. Among these two, the MNCS seeks to correct the MCS indicator for differences in citations characteristics between scientific fields. The normalized citation score of a publication presented by the MNCS indicator equals the ratio of the actual and the expected number of citations of the publication, where the expected number of citations is defined as the average number of citations of all publications belonging to the same field and having the same publication year and document type. If, for instance, a unit's MNCS score is 1, this means that its publications have been cited as often as would be expected on average for a publication in this particular field. A MNCS score of 2 means that the unit's publications have been cited twice as often as would be expected on average in this field.

[69] MNJS is the second normalized impact indicator used by CWTS, designed to assess the value of the journals in which researchers publish their work. The MNJS indicator uses the average number of citations of all publications published in a particular journal, instead of the actual number of citations of a publication underlying the MNCS. If a unit has an MNJS score of 1, this means that the group has published in journals that are cited as often as would be expected on average for the given field. A MNJS score of 2 means that the journal in which a unit has published its work is cited twice as often as would be expected on average in this field, the underlying assumption being that more frequent citations of a journal reflect the journal's higher status within the scientific field for which it is relevant.

[70] In addition to the normalized impact indicators MNCS and MNJS, CWTS uses the "PP(top 10 %)" indicator, correcting for some shortcomings in particular MNCS presents. This indicator depicts the proportion of publications of a unit belonging to the top 10 % most highly cited worldwide in a particular field. For each publication, it can be determined whether it belongs to this top 10 % in its field. The PP(top 10 %) indicator of a research entity therefore equals the proportion of its publications belonging to this top 10 %. In order to assess the impact of a unit's publications, CWTS recommends combining the MNCS and the PP(top 10 %) indicators, as the first can be influenced by publications with outstandingly large numbers of citations, which is not the case for the PP(top 10 %) indicator.

making use of these publications, to research results of high quality and a corres-ponding impact. While publications from ETH Zurich and EPFL are very well received among the world's leading universities, knowledge user analyses of the four research institutes additionally demonstrate their relevance for peer research institutions as well as for the public sector.

- In what follows, the individual results of the six institutions are presented by summarizing the most important elements of the conclusions drawn by CWTS. In addition, a figure presents the research profile of each institution, based on the current evaluation. The figures show the share of output of an institution attributed to a particular subfield (in percent of the total output of the institution). Per institution, only the 25 fields with the highest output are represented in the figure (see Table 1 below for the total output share these 25 fields represent at the respective institution). The bar shows the output share for the specific field, whereas the number integrated to the bar shows the normalized impact (MNCS) the institution has had in this field. It should be noted, however, that direct comparison is limited to a certain extent by the fact that the classifications of some of the subfields are subject to modifica-tions and refinement over time.
- The impact values are presented as low, average and high (coloured bars), the worldwide average being defined as the range from 0.8 to 1.2. A second figure shows the trend of the three main impact indicators (i.e. MNCS, MNJS and PP (top 10 %)).
- The share of the total output represented by the 25 fields considered in the figures is as follows:

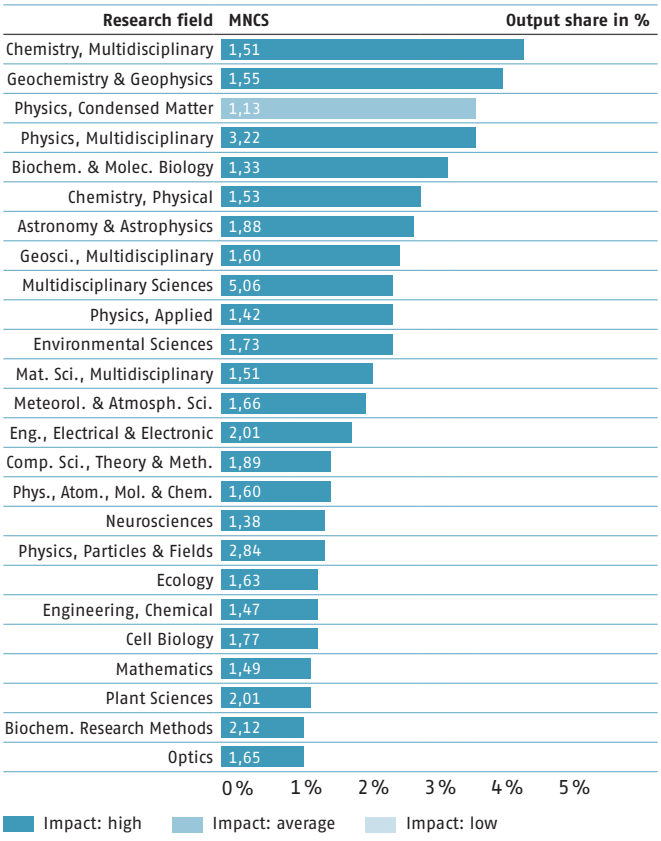
Table 1: Share of total output represented by the 25 fields considered

ETH Zürich	EPFL	PSI	WSL	Empa	Eawag
56 %	62 %	82 %	90 %	76 %	87 %

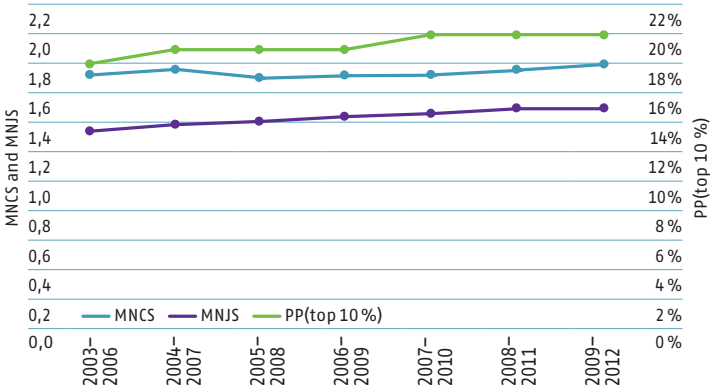
E.2.1 Results for ETH Zurich

- 35,719 publications have been attributed to ETH Zurich for the current evaluation period (2003–2012). These publications have been cited more than 618,000 times. Annual publication output shows a constant pattern of considerable increase.
- The impact indicators (MNCS and MNJS) show that ETH Zurich's output has an impact substantially higher than the worldwide average (MNCS = 1.75). In particular, the field normalized journal indicator, MNJS, shows a considerable increase over the years, from 1.38 in the first period to 1.51 in the last one. The fact that about 19 % of the publications published by ETH Zurich are among the top 10 % most highly cited publications in their field supports this statement.
- ETH Zurich's most active research fields are 'Chemistry, Multidisciplinary', 'Geochemistry & Geophysics', 'Physics, Condensed Matter', 'Physics, Multidisciplinary', 'Biochemistry & Molecular Biology', 'Chemistry, Physical', 'Astronomy & Astrophysics', 'Geosciences, Multidisciplinary', and `Multidisciplinary Sciences', each accounting for more than 2.5 % of ETH Zurich's research output. In the field of Multidisciplinary Sciences' (MNCS = 5.05; PP(top 10 %) = 49 %), and 'Physics, Multidisciplinary' ETH Zurich's impact is very high (MNCS = 3.22; PP(top 10 %) = 32 %), in the five fields 'Chemistry, Multidisciplinary', 'Geochemistry & Geophysics', 'Chemistry, Physical', 'Geosciences, Multidisciplinary', and 'Astronomy & Astrophysics', the impact is substantially above the world average (MNCS > 1.5; PP(top 10 %) > 16 %). Among the most active fields, the one with the lowest impact is 'Physics, Condensed Matter', with an MNCS value of 1.13 and a PP(top 10 %) of 13 %.
- While 72 % of ETH Zurich's publications involve some degree of collaboration, 57 % of all publications are elaborated with at least one international partner. Although the impact score is above the world average for all collaboration types, international collaboration yields the highest impact score (MNCS = 1.90; PP(top 10 %) = 21 %). Over the evaluation period, the share of publications not resulting from any collaboration and the share of publications resulting from national collaboration have diminished in favor of publications resulting from international collaboration.
- The knowledge user analysis indicates that international partners broadly cite the publications produced by ETH Zurich. In most cases, this itself leads to research of high quality. With regard both to individual countries and to the institutions using ETH Zurich's work, the analysis underlines the school's excellent worldwide reputation. In general, the fields that benefit most from ETH Zurich's work correspond to its fields of activity.

ETH Zurich: Output and normalized impact (MNCS) per field (chart represents 56 % of ETH Zurich's output)



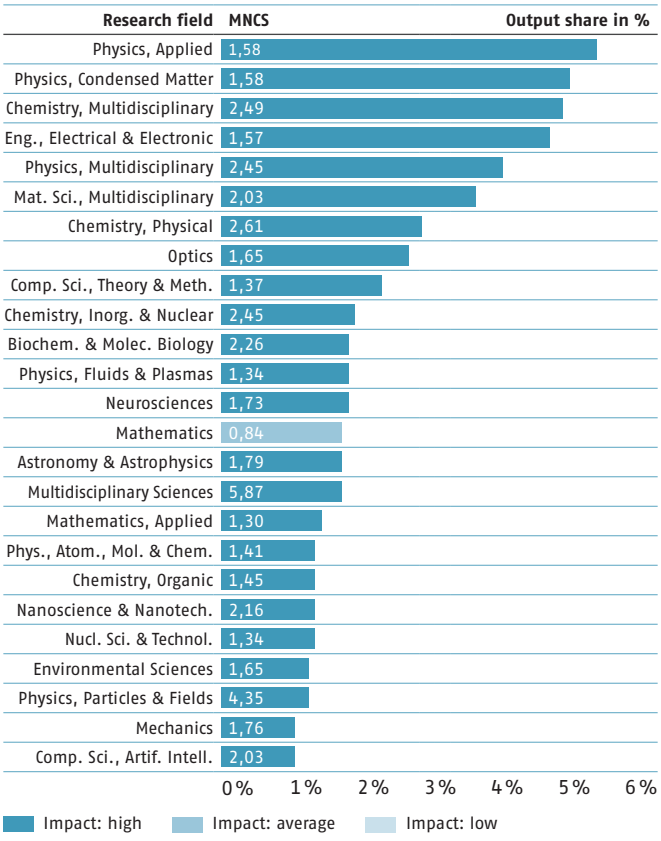
ETH Zurich: indicator trends



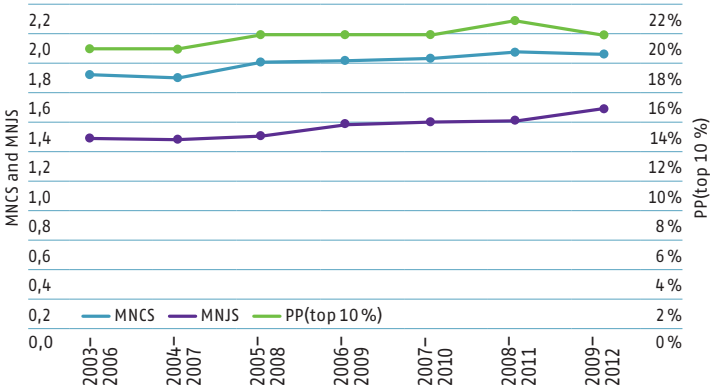
E.2.2 Results for EPFL

- 19,120 publications have been attributed to the EPFL for the current evaluation period (2003–2012). These publications have been cited almost 350,000 times. Annual publication output shows a constant pattern of considerable increase.
- The impact indicators (MNCS and MNJS) show that EPFL's output has an impact substantially higher than the worldwide average (MNCS = 1.91). Both field normalized impact indicators, particularly MNCS, show a considerable increase over the years. The fact that about 20 % of the publications published by EPFL are among the top 10 % most highly cited publications in their field supports this statement.
- EPFL's most active research fields are 'Physics, Applied', 'Physics, Condensed Matter, 'Chemistry, Multidisciplinary', 'Engineering, Electrical & Electronic', 'Physics, Multidisciplinary', 'Materials science, multidisciplinary', and 'Chemistry, physical', each accounting for at least 2.5 % of EPFL's research output. While the impact in the fields of 'Physics, Multidisciplinary', 'Chemistry, Multidisciplinary', and 'Chemistry, physical' is very high (MNCS > 2.4; PP(top 10 %) >25 %), it is still substantially above the world average in the other four fields (MNCS > 1.5; PP(top 10 %) >16 %).
- While 72 % of EPFL's publications involve some degree of collaboration, 60 % of all publications are elaborated with at least one international partner. Although the impact score is above the world average for all collaboration types, international collaboration yields the highest impact score (MNCS = 2.07; PP(top 10 %) = 21 %). Over the evaluation period, the share of publications not resulting from any collaboration and the share resulting from national collaboration have decreased in favor of publications resulting from international collaboration.
- The knowledge user analysis shows that the publications produced by the EPFL have a very high impact among international partners, again leading in most cases to high-quality research above the world average. With regard both to individual countries and to the institutions using EPFL's work, the analysis underlines the school's excellent worldwide reputation. In general, the fields that benefit most from EPFL's work correspond to its fields of activity. However, the analysis has identified several fields, such as 'Cell Biology', 'Biotechnology & Applied Microbiology', and 'Biochemical Research Methods', in which the EPFL's work has a very high impact although they are not among its main research areas. This could indicate potential areas for development.

EPFL: Output and normalized impact (MNCS) per field (chart represents 62 % of EPFL's output)



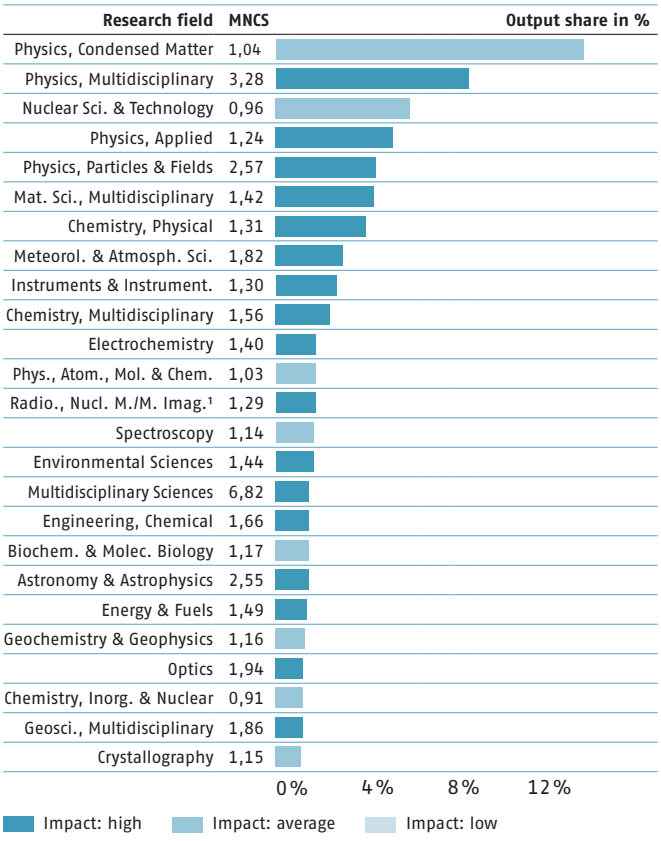
EPFL: indicator trends



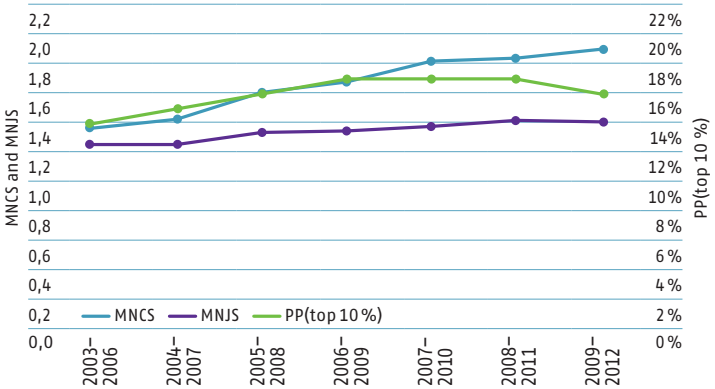
E.2.3 Results for PSI

- 7,717 publications have been attributed to the PSI for the current evaluation period (2003–2012). These publications have been cited more than 109,000 times. Annual publication output shows a steady and considerable increase.
- The impact indicators (MNCS and MNJS) show that the PSI's output has an impact substantially higher than the worldwide average (MNCS = 1.67). With regard to the field normalized impact indicators, the MNCS indicator in particular shows a considerable increase over the entire period. The fact that about 16 % of the publications published by PSI are among the top 10 % most highly cited publications in their field supports this statement.
- PSI's most active research fields are 'Physics, Condensed Matter', 'Physics, Multidisciplinary', 'Nuclear Science & Technology', 'Physics, Applied', 'Physics, Particles & Fields', 'Materials Science, Multidisciplinary', and 'Chemistry, Physical'. The impact indicators show that within these fields, accounting each for at least 4 % of PSI's research output, the scores differ from field to field. While the impact is very high in the field of 'Physics, Multidisciplinary' and high in the fields of 'Physics, Applied', 'Physics, Particles & Fields', 'Materials Science, Multidisciplinary', and 'Chemistry, Physical', it is average in the fields of 'Physics, Condensed Matter', and 'Nuclear Science & Technology'.
- While 85 % of PSI's publications involve some degree of collaboration, 70 % of all publications are elaborated with at least one international partner. Although the impact score is above the world average for all collaboration types, international collaboration clearly is the type that results in the highest citation impact (MNCS > 1.80; PP(top 10 %) = 17 %). The predominance of international collaboration underscores the PSI's strong international position and the high priority it accords to international collaboration.
- The knowledge user analysis shows that the publications produced by the PSI have a very high impact among international partners all over the world. With regard to individual countries and to the institutions using the PSI's work, the analysis underlines the Institute's excellent worldwide reputation, both among universities and public research organizations.

PSI: Output and normalized impact (MNCS) per field (chart represents 82 % of PSI's output)



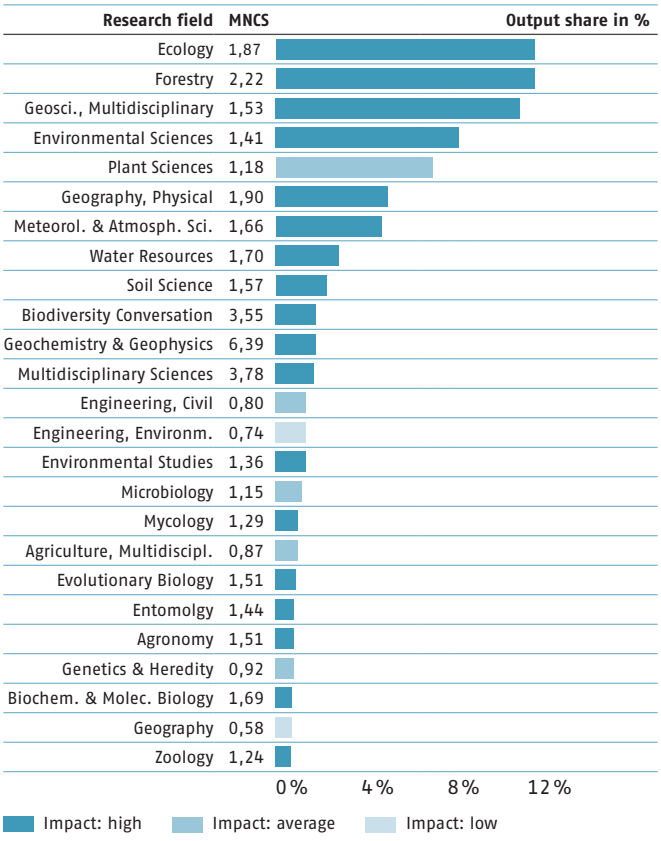
PSI: indicator trends



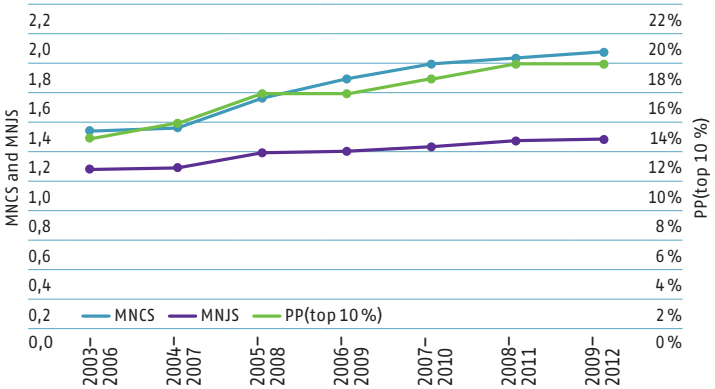
E.2.4 Results for WSL

- 2,068 publications have been attributed to WSL for the current evaluation period (2003–2012). These publications have been cited more than 30,700 times. Both with regard to publication output and to its impact, the trend shows a steady and considerable increase.
- The impact indicators (MNCS and MNJS) show that WSL's output has an impact well in excess of the worldwide average (MNCS = 1.75). Both impact indicators, but in particular the MNJS, show a constant increase over the evaluation period. The fact that 18 % of WSL's publications are among the top 10 % most highly cited publications in their field supports this statement.
- WSL's most active research fields are 'Forestry', 'Ecology', 'Geosciences, Multidisciplinary', 'Environmental Sciences', 'Plant Sciences', 'Geography, Physical', and 'Meteorology & Atmospheric Sciences', all of them related to the research focus set by WSL. In all these fields, WSL's impact is very high, with the exception of 'Plant Sciences', where it is average (but only slightly beneath the threshold to be considered as high).
- While 81 % of WSL's publications involve some degree of collaboration, 57 % of all publications are elaborated with at least one international partner. Although the impact score is above the world average for all collaboration types, international collaboration is the type of collaboration with the highest citation impact. It has remarkably high impact values, with a MNCS of around 2.16 and 21 % of these publications ranking among the top 10 % most cited in the world.
- The knowledge user analysis shows that the publications produced by the WSL have a high impact among international partners all over the world. They again lead in most cases to research of high quality. With regard to individual countries and to the institutions using WSL's work, the analysis underlines the institute's excellent worldwide reputation, both among universities and public research organizations.

WSL: Output and normalized impact (MNCS) per field (chart represents 90 % of WSL's output)



WSL: indicator trends

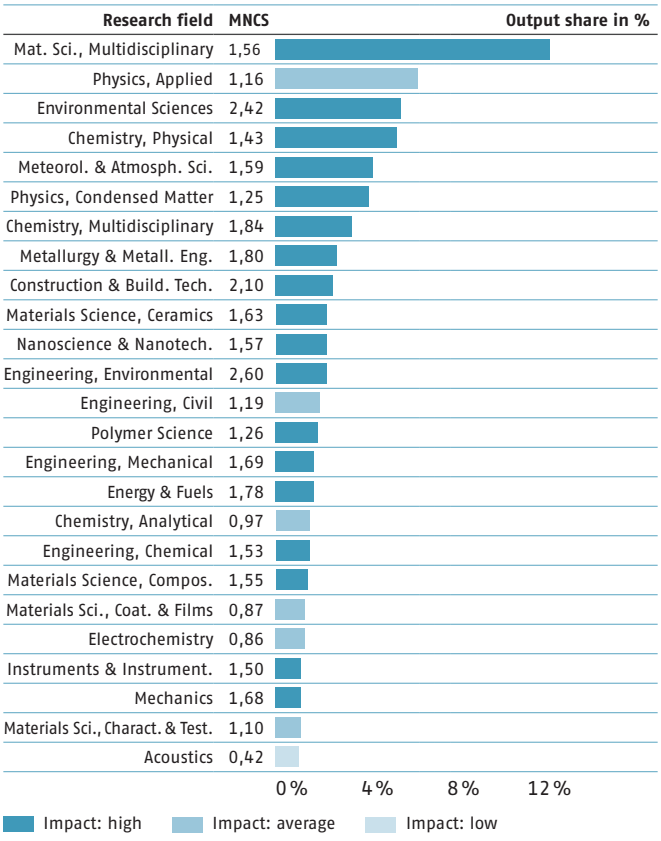


E.2.5 Results for Empa

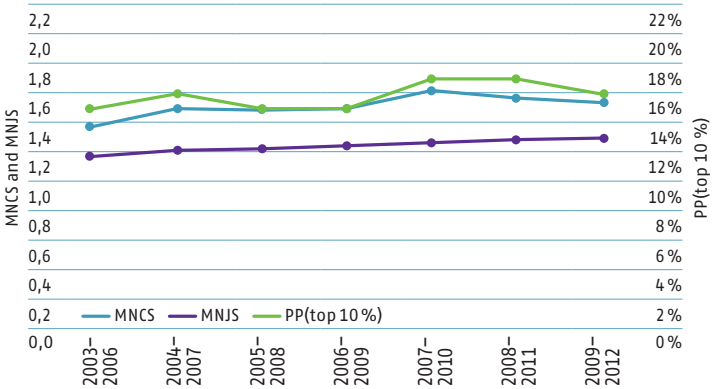
- 3,452.5[71] publications have been attributed to Empa for the current evaluation period (2003–2012). These publications have been cited more than 42,000 times. Annual publication output shows a constant pattern of considerable increase.
- The impact indicators (MNCS and MNJS) show that Empa's output has an impact well in excess of the worldwide average (MNCS = 1.56). Both impact indicators, but in particular the MNJS, show an increase over the evaluation period. The fact that 17 % of Empa publications are among the top 10 % most highly cited publications in their field supports this statement.
- Empa's most active research fields are 'Materials Science, Multidisciplinary', 'Physics, Applied', 'Environmental Sciences', and 'Chemistry, Physical'. These fields, in combination with the less important fields, indicate that Empa is a multidisciplinary research institute, combining physics, chemistry and a number of other scientific disciplines in its materials science research. Apart from 'Physics, Applied', Empa's impact in these fields is high or very high (MNCS > 1.4 and even higher than 2.6 for one field, MNJS > 1.25 and PP(top 10 %) > 16 %).
- While 78 % of Empa's publications involve some degree of collaboration, more than half of all publications are elaborated with at least one international partner. Although the impact score is above the world average for all collaboration types, international collaboration is the type of collaboration with the highest citation impact (MNCS = 1.64; PP(top 10 %) = 18 %). The MNJS scores, in contrast, are evenly distributed over the different types of collaboration.
- The knowledge user analysis shows that the publications produced by Empa have a very high impact among international partners all over the world. They again lead in most cases to research of high quality. From an institutional point of view, Swiss institutes from the ETH Domain are very important users of Empa's knowledge. Other important institutional knowledge users are found in China, the USA and Europe. With regard to individual countries and to the institutions using Empa's work, the analysis underlines the latter's excellent worldwide reputation, both among universities and public research organizations.

[71] The fraction number results from the fact that letters are given a weighting of 0.25 (see above, E.1).

Empa: Output and normalized impact (MNCS) per field (chart represents 76 % of Empa's output)



Empa: indicator trends

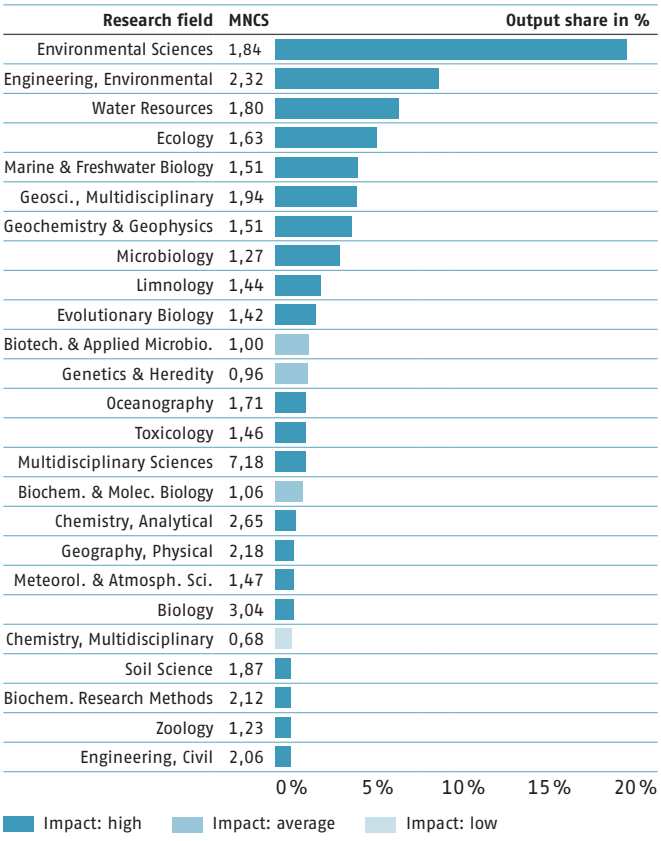


E.2.6 Results for Eawag

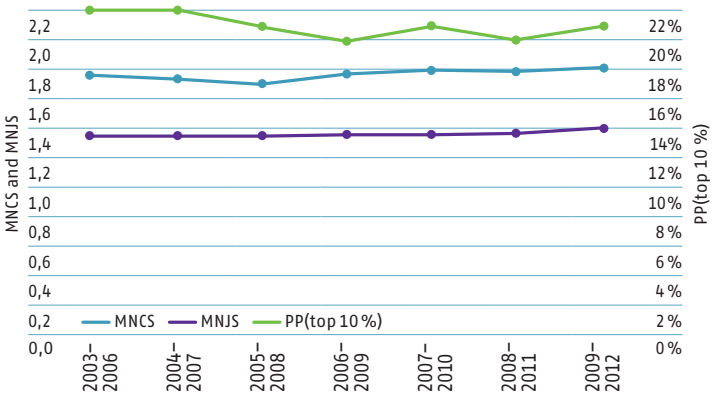
- 2,459.75[72] publications have been attributed to Eawag for the current evaluation period (2003–2012). These publications have been cited more than 45,000 times. Annual publication output shows a constant pattern of considerable increase.
- The impact indicators (MNCS and MNJS) show that Eawag's output has an impact substantially higher than the worldwide average (MNCS = 1.81). All impact indicators show an upward trend over the evaluation period. The fact that more than 20 % of the Eawag's publications are among the top 10 % most highly cited publications in their field supports this statement and depicts Eawag's important role worldwide.
- Eawag's most active research fields are 'Environmental Sciences', 'Engineering, Environmental', 'Water Resources', and 'Ecology', all of them fitting perfectly in the thematic orientation of an aquatic institute such as Eawag. The impact in all these fields is very high (MNCS always > 1.60, MNJS > 1.20 and PP(top 10 %) > 20 %).
- While 82 % of Eawag's publications involve some degree of collaboration, more than half of all publications are elaborated with at least one international partner. Although the impact score is above the world average for all collaboration types, international collaboration is the type of collaboration with the highest citation impact. This is reflected in the fact that publications with this type of collaboration have MNCS values of around 1.90, while 22 % of these publications are among the top 10 % most cited of the world. Remarkably, non-collaborative Eawag publications also exhibit a high impact level, with MNCS values around 1.70 and around 20 % of the publications classified as among the top 10 % in the world. Publications in collaboration only with other Swiss partners show a lower average impact than internationally collaborative or even non-collaborative papers; but these publications still present a very good overall impact performance level, with MNCS values around 1.60 and with 18 % of these publications among the top 10 % publications.
- The knowledge user analysis shows that the publications produced by Eawag have a high impact among international partners all over the world. They again lead in most cases to research of high quality. The partners are a mixture of institutes: public research institutes and universities, and broad universities as well as universities with (partially) a life sciences profile. With regard to individual countries and to the institutions using Eawag's work, the analysis underlines the latter's excellent worldwide reputation, both among universities and public research organizations.

[72] The fraction number results from the fact that letters are given a weighting of 0.25 (see above, E.1).

Eawag: Output and normalized impact (MNCS) per field (chart represents 87 % of Eawag's output)



Eawag: indicator trends



E.3 Conclusions

As stated above, the bibliometric analysis confirms the excellent performance of the ETH Domain institutions and the assessment made by the ETH Board in its annual reports. The constant increase in output and, most importantly, the impact of the institutions' publications – achieved despite the already very high performance depicted by the previous analyses – testify to appropriate strategic decisions and to the institutions' good operating environment. The following table summarizes the comparison between the previous evaluation period (2000–2009) and the current evaluation period (2003–2012):

	ETH Zürich			**EPFL**			**PSI**		
	P_1	P_2	Δ	P_1	P_2	Δ	P_1	P_2	Δ
MNCS	1.67	1.75	4.8 %	1,85	1,91	3,2 %	1,46	1,67	14,4 %
MNJS	1.38	1.45	5.1 %	1,39	1,44	3,6 %	1,25	1,35	8 %
PP (top 10%)	18 %	19 %	5.5 %	19 %	20 %	5,3 %	14 %	16 %	14,3 %

	WSL			**Empa**			**Eawag**		
	P_1	P_2	Δ	P_1	P_2	Δ	P_1	P_2	Δ
MNCS	1,64	1,75	6,7 %	1,51	1,56	3,3 %	1,81	1,81	0 %
MNJS	1,19	1,24	4,2 %	1,22	1,27	4,1 %	1,39	1,38	-0,7 %
PP (top 10%)	17%	18%	5,9 %	15%	17%	13,3 %	22%	21%	-4,4 %

P1 = 2000–2009
P2 = 2003–2012

As the evaluation shows, all institutions exert the highest impact in their main fields of activity. These are the fields in which they have been able to achieve the highest standards of research and teaching and in which they operate with the greatest autonomy in terms of the allocation of resources. By pointing to these linkages, the bibliometric evaluation underlines the vital importance that has been attributed in the first chapters of this report to academic autonomy and stable basic funding. Both factors contribute to the ETH Domain institutions' performance as shown in the present bibliometric evaluation.

Most importantly, the evaluation also underlines the ETH Board's insistence on openness and a rigorous international orientation of the ETH Domain institutions. Not only is international collaboration – in particular with regard to scientific publications – of growing importance (not least at the level of quantitative output) but, first and foremost, it is increasingly a prerequisite for high-impact research. This is supported by the fact that, for all ETH Domain institutions, publications resulting from international collaboration are not only predominant in terms of numbers but also have the greatest impact – much greater, in fact, than for publications arising from national collaboration or produced by single institutions.

F
Retrospective and Outlook

F
Retrospective and Outlook

F.1 Implementation of the Experts' Recommendations of the 2010 Intermediate Evaluation

As requested by the evaluation mandate, the ETH Board reports "on the extent to which the experts' recommendations made in the 2010 intermediate evaluation were implemented. If a recommendation was disregarded, reasons for this should be given." In its response to the 2010 expert report, the ETH Board has identified 24 recommendations put forward by the committee, some of them, however, being identical in scope and content.

All recommendations have been carefully taken into account by the ETH Board as well as by the ETH Domain institutions concerned, and have been thoroughly examined. Most recommendations have been implemented. In six cases, however, examination of the recommendation and the first steps undertaken prompted the ETH Board to decide against further implementation. *Appendix 3* presents the relevant information on the follow-up and the status of implementation for each recommendation, including explanations in the case of the recommendations that have been disregarded.

Four recommendations that have not been implemented, however, will be addressed in the present chapter. The numbers attributed to the individual recommendations both in this chapter and in Appendix 3 refer to the numbers structuring the ETH Board's Response to the Peer Report on the 2010 Intermediate Evaluation.[73]

Branding (Recommendation 1c)
In the 2010 intermediate evaluation, the peers suggested that the ETH Domain should "strive for a Domain branding for Switzerland while respecting the strong international brands of the partners." As the ETH Board stated in its response to the Peer Report, a process destined at creating a common brand for the entire ETH Domain had been launched in 2009. After intensive work, including an internal consultation process within the ETH Domain institutions on a concrete proposal of the ETH Board, it was decided to discontinue the branding project in December 2012. As the ETH Board's final report on the performance period 2008–2011/12 states, the following steps have been undertaken in the meantime:

- In summer 2009, the ETH Board decided to further develop a project that would allow the ETH Domain institutions to maintain their strong individual brands, which will be supplemented by a common by-line referring to the Domain ("endorsed brand model").
- Between 2009 and 2010, a "Communications Framework for the ETH Board and the ETH Domain" analyzed and documented potential solutions, including the view of stakeholders, politicians and media, and drawing also on the international perception of the ETH Domain.
- As mentioned by the ETH Board in its response to the Peer Report of 2010, five fields of action for reinforced communication were designated, one of which focuses on the development of a common brand.

[73] This document can be found, for instance, on the website of the State Secretariat for Education, Research and Innovation (SERI): http://www.sbfi.admin.ch/themen/hochschulen/01623/index.html?lang=de (last accessed: November 24, 2014).

- Subsequently, and despite the reservations expressed within some institutions, the ETH Board together with representatives of the ETH Domain institutions has developed a common brand. The brand has been protected internationally.
- During 2012, a formal consultation (as requested by the ETH Act) was held within the ETH Domain. This consultation was also addressed to internal bodies – such as the University Assemblies of ETH Zurich and EPFL or the Internal Appeals Commission – who had not yet been involved in the previously confidential process.
- The consultation revealed that both Federal Institutes of Technology were – for different reasons – opposed to the proposed brand. At its meeting in December 2012, the ETH Board discussed the results of the consultation in detail. Based on the results of the consultation, it acknowledged that no consensus between the diverging needs and positions of the ETH Domain institutions could be reached.
- On these premises, balancing the interests and chances of success, and in light of its current priorities, the ETH Board decided to abandon the ETH Domain branding project.

Nomination of an International Advisory Board (Recommendation 2a)

- As announced in its response to the Peer Report, the ETH Board studied the options for establishing an international advisory board. It considered the possibility of constituting a small board comprising members of existing advisory boards at the individual institutions who are familiar with the ETH Domain.
- However, such international advisory boards and/or research commissions exist at ETH Zurich and EPFL as well as at the Research Institutes and are considered most valuable for the individual development of these institutions.
- After examining this option, the ETH Board therefore came to the conclusion that an advisory board additional to the ETH Board would result in unnecessary and potentially conflicting redundancies.
- Furthermore, the periodic evaluations with international expert panels of entire institutions or their units – as performed by the institutions on a regular basis – were considered to be much better positioned for providing the intended international perspective.
- The institutions are required to bring these evaluations to the attention of the ETH Board, which gives the ETH Board valuable insights into the appraisal of the institutions' activities and strategies with regard to their international positioning.
- Therefore, the nomination of an additional international advisory board has not been pursued by the ETH Board.

Nominating the Chair of the International Advisory Board as a Regular ETH Board Member (Recommendation 4a)

- Closely linked to the considerations presented in recommendation 2a) above, the ETH Board concluded that chairing an advisory board and at the same time acting as a member of the ETH Board would generate a workload that would make such a function unattractive for high-caliber individuals.
- The members of the ETH Board spend at least ten days at regular meetings and six days in the annual dialogs with the institutions of the ETH Domain.
- A (national) Board member who would have to chair the international advisory board would have to spend additional time for this function. If that member were to be an international member, the substantial amount of travel time would put an even larger burden on him or her.

- This view has been confirmed by the experience of trying to appoint an international regular member of the ETH Board. The search of such a regular board member had to be terminated as it became clear that potential candidates considered they would have to spend too much time travelling just in order to be able to attend the regular board meetings.
- Given the conclusions drawn with regard to the nomination of an international advisory board and taking into account this experience, the ETH Board has deemed it inappropriate to follow up on the appointment of an international board member (even if this member were not to be considered as the chairman of an international advisory board).

Own and Manage Real Estate and Facilities (Recommendation 4b)

- As stated in its response to the Peer Report, the ETH Board welcomed this recommendation and took up "the issue of working towards the long-term goal of transferring real estate into the ETH Domain in its Action Plan for 2011". Hence the advantages and disadvantages of a transfer of ownership of real estate were carefully assessed by the ETH Board. In parallel, negotiations with the Swiss Confederation as the owner resulted in substantially improved flexibility in the usage of the Confederation's real estate within the ETH Domain:
- The ETH Board's competency has been extended, allowing the transfer of up to 20 % of the budget for investments to the "Finanzierungsbeitrag", i.e. the Confederation's financing contribution covering operating expenses.
- The ETH Board was further granted the option of transferring credit to the following year if needed, plus the possibility of re-investing revenues from real estate sales and applying alternative financing models involving private parties.
- Considering these substantial improvements, the ETH Board decided in December 2011 to put further attempts to transfer ownership of real estate to the ETH Domain on hold. In doing so, it also sought to avoid the significant disadvantage of assuming liability and other potentially costly duties incumbent upon a real estate owner.

F.2 Executive Summary of the Strategic Planning 2017–2020[74]

Through high-quality teaching and innovative research, knowledge and technology-based foundations, the ETH Board's strategic planning 2017–2020 for the ETH Domain seeks to provide a basis for the sustainable development of society. A further aim is to strengthen the long-term competitiveness of the ETH Domain for the benefit of Switzerland as a centre of education, research and innovation, and thus as a place to work. This requires not only adequate resources for the basic mission of the six institutions and for long-term competitive working conditions, but also targeted investment in research infrastructures of national importance, as well as in four strategic focus areas. Specific efforts to maintain the quality of research-based teaching are also called for. The ETH Board is therefore asking the Swiss Federal Council and Parliament to approve a budget appropriation of CHF 11 billion. This overall requirement for 2017–2020 assumes an annual increase in resources of 3.5 % based on government funding of the ETH Domain for 2016. For the achievement of its objectives, the ETH Board also stresses the importance of a number of key framework conditions for science policy.

[74] Quoted and translated from the Strategic Planning 2017–2020 of the ETH Board.

Vision

The ETH Domain will be pursuing the following vision during the ERI period 2017–2020: *"As a driving force for innovation, the ETH Domain wishes to strengthen Switzerland's long-term competitiveness through excellence in research, teaching and knowledge and technology transfer, and to contribute to the development of society. Acting as a beacon, it will seek to assume its share of global responsibility for tackling urgent social challenges, for improving quality of life and for the long-term preservation of the resources our lives depend on."*

Current position of the ETH Domain

The ETH Domain excels through its combination of exact sciences, natural sciences and engineering sciences plus specific complementary expertise in social sciences and humanities. The close networking of the two Federal Institutes of Technology in Zurich and Lausanne and the four research institutions PSI, WSL, Empa and Eawag, and their responsibility for large-scale research infrastructures and technology platforms, create a unique setting for high-quality innovative research, teaching and training in the ETH Domain which permeates Switzerland as a centre of science and research.

The ETH Domain is excellently positioned: the courses taught at the two Federal Institutes of Technology enjoy strong demand; both nationally and internationally, their superlatively trained graduates are sought-after specialists with excellent career prospects; teaching and research are of the highest calibre worldwide and this is reflected in impressive successes in competition for research funding, as well as in top positions in international rankings and prestigious awards. Through its alumni, through a needs-oriented range of continuing education courses and through the practical application of scientific discoveries in the form of marketable developments and innovations, the ETH Domain makes a significant contribution to Switzerland's international competitiveness.

Challenges

The ETH Board sees the following challenges:

- The growth in the number of students and doctoral candidates to date and in the future needs to be addressed if the quality of research-based education and training is to be maintained and developed.
- The current and planned research infrastructures of national importance based in the ETH Domain need to be financed, operated and developed/implemented in a way that guarantees access to these state-of-the-art research infrastructures for science and business.
- The ETH Domain is eager to meet the urgent challenges facing society today and in the future, notably in areas where science is expected to be make a key contribution.
- Switzerland's internationality and openness, and its university system – which facilitates the movement of scientists and academics, as well as national and international cooperation with other research groups and institutions – must be secured for the future and be anchored more firmly in society.

Strategic success factors

In the present Strategic Plan for 2017–2020, the ETH Board sets out the strategic success factors through which it intends to master these challenges and put its vision into practice:

- *First-class, research-based teaching:* First-class, research-based training with optimum supervision is an absolute priority. It requires a targeted effort: up to 55 additional professorships will make it possible to guarantee strong links between training and current research, advances into new areas of research and a good student/teacher ratio. The growing number of students, doctoral candidates and professorships, coupled with the diversification of curricula and learning environments, have created a need for more investment in teaching,

training and learning infrastructure at the six institutions. The two Federal Institutes of Technology will also aim at establishing the total number of their students and doctoral candidates around their target figures (ETH Zurich: 20,000; EPFL: 11,000) between now and 2020.

- *Research infrastructures of nationwide importance:* State-of-the-art infrastructure is crucial to ensuring Switzerland's international competitiveness as a centre of research and innovation. The following four research infrastructure projects are strategic priorities: the Sustained scientific user lab for simulation based science (HPCN-20) attached to the Swiss National Supercomputing Centre (CSCS) of ETH Zurich; the Blue Brain neuroinformatics project at EPFL, which is part of the European FET flagship Human Brain Project; the expansion of the SwissFEL facility at PSI (ATHOS/SwissFEL); and the upgrading of the CMS detectors headed by ETH Zurich.
- *Strategic areas of focus in research:* The four focus areas jointly defined by the ETH Board and the institutions – "Energy", "Personalized medicine and medical technologies", "Big data and digital sciences" and "Advanced manufacturing" – address social challenges and open up essential strategic areas of research for the development of the ETH Domain's portfolio. To this end, existing expertise in the ETH Domain is being focused and new initiatives of the institutions are being supported in a coordinated manner.
- *Attractive employment conditions:* Outstanding scientists, promising young talent and highly qualified employees in the administrative and technical sectors are essential requirements if the institutions of the ETH Domain are to fulfil their statutory mandate and achieve their ambitious strategic objectives. If they are to nurture potential and attract new staff, the institutions depend on a favourable political and financial framework enabling them to offer an inspiring working environment with attractive and internationally competitive working conditions. During its annual negotiations and pay rounds with the social partners, the ETH Board for its part needs to have some financial room for manoeuvre so that it can offer progressive working conditions with a pay policy that will remain competitive with the private sector and the Federal administration over the longer term.

Funding requirements 2017-2020

The ETH Board allocates the lion's share of the annual Federal grant to the six institutions to enable them to fulfil their basic mandate. In this way, they ensure that they implement their institutional substrategies for the development of the portfolio in teaching, training and research (including some of the additional professorships), Knowledge and Technology Transfer and properties. If the basic mandate is to be fulfilled, funding needs to increase by 2.5 % per year (around CHF 10,191 million in total) as there is also a need to compensate for inflation.

A total of CHF 699 million is required for the successful and timely implementation of the four strategic success factors:

- CHF 272 million for first-class research-based teaching (CHF 122 million for additional professorships, a further CHF 150 million required for investment in property).
- CHF 237 million for the four major research infrastructures of national importance,
- CHF 110 million for the strategic areas of focus in research, and
- CHF 80 million for attractive working conditions.

In addition, CHF 115 million is required for reserves at Publica (CHF 80 million) and for the dismantling of the PSI's accelerator facilities (CHF 35 million). The present resource requirement planning thus results in a total financial requirement of CHF 11,005 million. The ETH Board is therefore asking the Swiss Federal Council and Parliament to approve this sum as the budget appropriation for the ETH Domain for the ERI period 2017-2020. The overall requirement for 2017-2020 assumes an annual increase in funding of 3.5 % based on Federal government funding of the ETH Domain for 2016.

Science policy framework as a foundation for success

The most important requirements for the continuing success of the ETH Domain are that the Swiss Confederation as funding provider should ensure a top-quality operating environment (securing in particular the autonomy of the institutions of the ETH Domain, political stability and stable core funding) and that the institutions of the ETH Domain should be firmly anchored in Switzerland's society and economy. In the ETH Board's view it is crucially important that

- we continue to ensure that Swiss universities and research institutions are able to attract and retain excellent scientists and the best students solely on the basis of their qualifications and potential;
- from 2017 onward we endeavour to restore Switzerland's full association with the European Research Framework Programme Horizon 2020 instead of the current partial association;
- at national level we should only establish instruments for the promotion of young academic talent which do not undermine the autonomy of the universities and their strategic development planning;
- restraint should be exercised at all levels before imposing excessive regulation and control on academic institutions, particularly in the context of cooperation with business and efforts to obtain funding from third parties.

Appendices

Appendices

For reporting on the fulfilment of the performance mandate, reference is made to the separate appendix reproducing the "insight" section of the Annual Report 2013 (separate inlet brochure).

Appendix 1: Unique Features and Governance of the ETH Domain[75]

The Unique Features of the ETH Domain (Alleinstellungsmerkmale)

The ETH Domain has three unique strategic features: its wide range of combinations encompassing exact, natural and engineering sciences, management studies, social sciences and humanities; the complementary nature of the two Federal Institutes of Technology and the Research Institutes; and its development and operation of major research infrastructures. These features enable the six institutions to maintain a high profile nationally and internationally and to create significant added value for the higher education and research sector in Switzerland.

Spectrum of disciplines permits unique combinations
In Switzerland, only the two Federal Institutes of Technology offer engineering programmes at university level. Because of their spectrum of disciplines, only the ETH Domain institutions are able to combine exact, natural and engineering sciences (incl. architecture), as well as management studies, social sciences and humanities in a wide variety of ways, thus placing their knowledge and new discoveries in a societal and economic context while also submitting them to expert scrutiny. This broad interdisciplinary networking within the ETH Domain is decisive with a view to being able to tackle complex current and future challenges in society, business and politics in a manner that focuses on solutions. With their targeted knowledge and technology transfer work, the six institutions also help ensure that their new discoveries lead to successful and marketable innovations.

Complementary nature of the Federal Institutes of Technology and Research Institutes
The two Federal Institutes of Technology and the four federal Research Institutes complement each other in terms of content and structure:

- The two Federal Institutes of Technology conduct their teaching, research (primarily basic research) and knowledge and technology transfer work to a standard which is on a par with the best universities in the world. Their courses build on solid basic training in mathematics and natural sciences. The two Federal Institutes of Technology maintain diversity by focusing on selected topics and engaging in interdisciplinary networking. In addition, they make a significant contribution to overcoming the global challenges of the 21st century in such areas as energy, food, data volumes, data security and risk management. The two Federal Institutes of Technology engage in intensive exchanges with business and public institutions at both national and international level. Academic independence is safeguarded by ensuring that professorships and research units are properly funded and that research agreements are drawn up in accordance with the relevant guidelines.

[75] Quoted and translated from the Strategic Planning 2017–2020 of the ETH Board.

– The four Research Institutes pursue topic-oriented, cutting-edge research supplemented with application-oriented research and technology development. Hence, they position themselves at the interface between basic research and technical or social implementation, thereby playing a key role in knowledge and technology transfer. Their working methods are predominantly interdisciplinary and transdisciplinary because they bring together expertise from various disciplines, and maintain a continuous dialogue with society, regulatory authorities, public administration and business. The diversity this entails and the synergy-based collaboration within the ETH Domain will contribute substantially to the ETH Domain's strength in the future too.

Research infrastructures of nationwide importance

The ETH Domain's portfolio of large-scale research facilities is especially important to ensuring innovative, solution-focused advancement of cutting-edge research in Switzerland and beyond. The institutions are equipped with state-of-the-art research infrastructures, many of which they make available for research in Switzerland, including a substantial proportion in the form of user labs. The ETH Domain exercises its specific responsibility for operation and maintenance, as well as for management tasks for the further development of such infrastructure and the associated research.

Organisation and Governance of the ETH Domain

Excerpt of pp. 22–25 of the Annual Report 2013 of the ETH Board on the ETH Domain

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Structure and leadership of the ETH Domain

As the law governing sponsorship of the ETH Domain, the ETH Act clearly defines the constitutional mission to operate the Swiss Federal Institutes of Technology. This act also provides the legal basis for the research institutes of the ETH Domain.

The ETH Domain and its environment
The Federal Act on the Federal Institutes of Technology (ETH Act) of 4 October 1991 defines the status, structure and mission of the ETH Domain. According to the legislative provisions, the ETH Domain is autonomous and the ETH Act stipulates that it is affiliated to the responsible federal department. The ETH Act also defines the autonomy of both Federal Institutes of Technology and – indirectly – the four research institutes. The ETH Board is the strategic leading and supervision body of the ETH Domain.

Mission and leadership
According to the principal mission set out in Art. 2 of the ETH Act, both Federal Institutes of Technology and the four research institutes (institutions of the ETH Domain) are to do the following:
- Educate students and specialists in scientific and technical fields and provide ongoing continuing education,
- Expand scientific knowledge through research,
- Foster upcoming young scientists,
- Render scientific and technical services,
- Perform public relations activities,
- Exploit their research findings.

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

Performance mandate and budget appropriation
The ETH Domain is managed according to an effect-oriented leadership model. The political authorities specify performance standards and key financial parameters, while the ETH Domain, as a service provider, is responsible for implementing the specifications.

Political leadership is the responsibility of the Federal Parliament and the Federal Council. The following elements serve as core leadership tools: the Federal resolution approved by Parliament, which includes a four-year budget appropriation; a performance mandate for the ETH Domain from the Federal Council, which is tailored to the budget; and the annual credit allocation from Parliament. The Federal resolution regarding budget appropriation over a four-year performance period is based on the Federal Council's dispatch on the promotion of education, research and innovation. These political tools are supplemented by financial controlling, which provides information on the accounts and mission fulfilment.

The ETH Board's reporting system comprises three parts: in the Annual Report, the ETH Board focuses on the achievement of the performance goals and illustrates how the annual federal financing contribution has been used. In a self-evaluation report in each half of the performance period, the ETH Board indicates the extent to which the goals of the performance mandate have already been met. At the end of the performance period, the ETH Board produces a final report showing how the performance mandate was fulfilled during the performance period just ended. The final report must be approved by the Swiss Federal Assembly.

The ETH Board is responsible for the *strategic leadership* of the ETH Domain (see next section). Responsibility for the *operational leadership* of the individual institutions of the ETH Domain lies with the members of the Executive Boards of both Federal Institutes of Technology and the Directorates of the four research institutes. In accordance with Art. 4 Paragraph 3 of the ETH Act, the institutions of the ETH Domain assume all responsibilities which are not assigned to the ETH Board by the ETH Act.

ETH Board: Mission and operating principles
The ETH Board defines the strategy of the ETH Domain within the framework of the performance mandate, represents the ETH Domain to the government and government authorities at federal level, issues controlling directives, carries out strategic controlling, approves the development plans of the institutions of the ETH Domain, oversees their implementation and supervises

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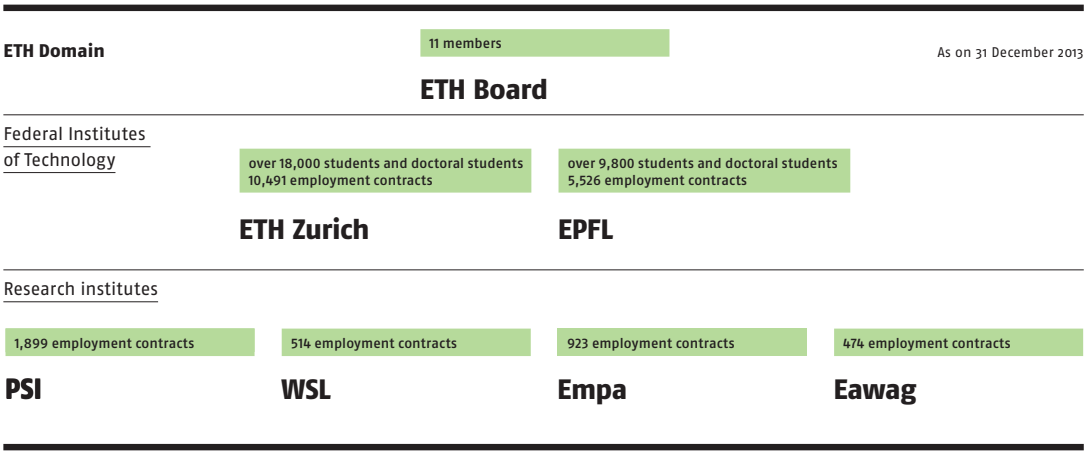
Organisation and governance



the ETH Domain. It agrees targets with the institutions and allocates Federal funding on the basis of the institutions' budget requests. It submits requests to the Federal Council for the selection of the Presidents of both Federal Institutes of Technology and of the Directors of the four research institutes, elects the other members of the Executive Boards of both Federal Institutes of Technology and appoints the other members of the directorates of the four research institutes. Finally, the ETH Board appoints professors at the request of the Presidents of both Federal Institutes of Technology.

The ETH Board performs its supervisory function through the use of the following tools: periodic reporting from the institutions on resources (finances, human resources, real estate), annual reporting from the institutions on the status of mission fulfilment with regard to agreed targets, annual strategic controlling talks between the ETH Board and the institutions (known as dialogues) and reports from the institutions within the framework of their risk management systems. Moreover, the ETH Board's Internal Audit staff evaluate the risk management processes, internal control system and governance processes of the institutions and report on them to the ETH Board, in particular the ETH Board's Audit Committee.

The rules of procedure of the ETH Board are published in the compilation of Federal law. The ETH Board meets five times a year for one or two days at a time. It met for ten days in 2013 and spent another seven days in dialogues with the institutions of the ETH Domain. The ETH Board meetings focused on strategic and budgetary discussions, the reporting of the institutions, the appointment of professors and the selection or appointment of prominent figures for the vice-presidencies and directorates of the institutions. Finally, it put forward a proposal to the Federal Council for the election of the new President of ETH Zurich, who will take up office on 1 January 2015.

Proprietor discussions are held twice a year between the President of the ETH Board, the General Secretariat of the Federal Department of Economic Affairs, Education and Research (EAER), the State Secretariat for Education, Research and Innovation (SERI) and the Director of the Federal Finance Administration (FFA). The President of the ETH Board is responsible for holding periodic individual discussions with the Presidents of the two Federal Institutes of Technology and the Directors of the research institutes, who present reports on the strategic development of their institutions.

Audit and Executive Committees

The Audit Committee assists the ETH Board in financial supervision and in the monitoring of risk management, of the internal control system and of financial auditing activities. It is generally composed of three ETH Board members who are independent of the executive leadership, but may also involve additional people in a consultative capacity. The head of the Internal Audit department and the head of the Finance section of the ETH Board's staff attend the meetings.

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

Remuneration of the ETH Board

In 2013, the President of the ETH Board received a salary of CHF 359,983 (including CHF 82,992 social insurance contributions) for his 80 % FTE position. In addition, he received an entertainment allowance of CHF 5,000. The President is insured by the Swiss Federal Pension Fund, the rules of which determine the employer's contribution. The other six members of the ETH Board who

President's Office and members of the ETH Board (Updated January 1, 2015)

The ETH Board of the current term of office (2012–2016) is made up of the following members:

- Dr Fritz Schiesser[1], President
- Prof. Dr Paul L. Herrling[2], Vice-President
- Prof. Dr Ralph Eichler[1] (until Dec. 2014)
- Prof. Dr Lino Guzzella[1] (since Jan. 2015)
- Prof. Dr Patrick Aebischer[1]
- Prof. Dr Joël Mesot[1]
- Beatrice Fasana Arnaboldi
- Dr Dr h. c. Barbara Haering[2]
- Beth Krasna[2]
- Jasmin Staiblin
- Dr Markus Stauffacher[1]
- Olivier Steimer

ETH Zürich
- Prof. Dr Ralph Eichler, President (until Dec. 2014)
- Prof. Dr Lino Guzzella, Rector (until Dec. 2014); President (since Jan. 2015)
- Prof. Dr Sarah Springmann, Rector (since Jan. 2015)
- Prof. Dr Roman Boutellier, Vice-President Human Resources and Infrastructure
- Prof. Dr Detlef Günter, Vice-President Research and Corporate Relations (since Jan. 2015)
- Dr Robert Perich, Vice-President Finance and Controlling
- Prof. Dr Roland Yves Siegwart, Vice-President Research and Corporate Relations (until Dec. 2014)

EPFL
- Prof. Dr Patrick Aebischer, President
- Prof. Dr Philippe Gillet, Vice-President Academic Affairs
- Prof. Dr Karl Aberer, Vice-President Information Systems
- Dr Adrienne Corboud Fumagalli, Vice-President Innovation and Valorisation
- Dr André Schneider, Vice-President Planning and Logistics

PSI
- Prof. Dr Joël Mesot, Director
- Dr Peter Allenspach, Member of the Directorate
- Dr Kurt N. Clausen, Member of the Directorate
- Prof. Dr Leonid Rivkin, Member of the Directorate
- Prof. Dr Gebhard F.X. Schertler, Member of the Directorate
- Prof. Dr Alexander Wokaun, Member of the Directorate

WSL
- Prof. Dr Konrad Steffen, Director
- Dr Christoph Hegg, Deputy Director
- Prof. Dr Rolf Holderegger, Member of the Directorate
- Dr Andreas Rigling, Member of the Directorate
- Dr Jürg Schweizer, Member of the Directorate
- Prof. Dr Niklaus Zimmermann, Member of the Directorate

Empa
- Prof. Dr Gian-Luca Bona, Director
- Dr Peter Richner, Deputy Director
- Dr Brigitte Buchmann, Member of the Directorate
- Dr Pierangelo Gröning, Member of the Directorate
- Prof. Dr Harald Krug, Member of the Directorate (until April 2014)
- Dr Urs Leemann, Member of the Directorate (since Oct. 2014)

Eawag
- Prof. Dr Janet Hering, Director
- Prof. Dr Rik Eggen, Deputy Director
- Prof. Dr Jukka Jokela, Member of the Directorate
- Dr Tove Larsen, Member of the Directorate (since Oct. 2014)
- Prof. Dr Peter Reichert, Member of the Directorate
- Prof. Dr Hansruedi Siegrist, Member of the Directorate (until Sept. 2014)
- Prof. Dr Bernhard Wehrli, Member of the Directorate (until Feb. 2015)
- Prof. Dr Alfred Johny Wüest, Member of the Directorate (since March 2015)

Legend
[1] Member of the Executive Committee
[2] Member of the Audit Committee

Status as of 31 December 2014 (changes that have already been decided in the year 2014 and that take effect in the year 2015 are also mentioned)

are not employees of any of the institutions of the ETH Domain each received a lump sum of CHF 20,000 in 2013. Additionally, they were paid a total of CHF 45,000 in meeting attendance remuneration and reimbursed for expenses actually incurred in accordance with the expenses rules. Those members of the ETH Board who are employees of one of the institutions of the ETH Domain do not receive additional fees for their activities on the ETH Board. For the scope of a 50 percent FTE position, the ETH Board covers the wage and social costs incurred by ETH Zurich for the representative of the University Assemblies of both Federal Institutes of Technology, in order to guarantee this representative's independence from any institution.

ETH Internal Appeals Commission
Administratively, the ETH Internal Appeals Commission is part of the ETH Board and decides on appeals against rulings made by bodies of the institutions of the ETH Domain. Appeals mainly relate to matters arising from legislation on human resources and higher education. Appeals against the rulings of the ETH Internal Appeals Commission can be made to the Federal Administrative Court.

Internal Audit
The Internal Audit department conducts internal audits for the institutions of the ETH Domain (Art. 35a Para. 1 of the ETH Act and Art. 11 of the Federal Audit Office Act). This department reports

Appeals authority

ETH Internal Appeals Commission 2013
The ETH Internal Appeals Commission is an independent judicial authority based in Bern and reports to the ETH Board.
- Prof. Dr Hansjörg Peter, President
- Beatrice Susanne Vogt, Vice-President
- Astrid Forster, Member
- Consuelo Antille, Member
- Jannick Griner, Member
- Yolanda Schärli, Member
- Prof. em. Rodolphe Schlaepfer, Member

directly to the President of the ETH Board and its activities are supervised by the Audit Committee. It provides independent, objective auditing services and supports the ETH Domain in achieving its aims by assessing the effectiveness of the risk management processes and of the internal control, monitoring and governance processes. It is also responsible for coordinating and supporting the external audits of the ETH Domain. The Internal Audit department reports on its own activities, in particular to the Audit Committee.

Auditors
The Swiss Federal Audit Office (SFAO) performs external auditing duties for the ETH Domain (Art. 35a Para. 3 of the ETH Act). It is responsible for auditing the accounts of the individual institutions of the ETH Domain and the ETH Domain's consolidated accounts. In 2013, the SFAO audited the financial statements of both Federal Institutes of Technology as well as the consolidated financial statements of the ETH Domain. As in previous years, it delegated the auditing of the financial statements of the four research institutes to PricewaterhouseCoopers, Bern. The SFAO's audit report on the consolidated accounts comprises a confirmation report and a management letter. The Audit Committee discusses these reports annually with representatives of the SFAO. In 2013, the SFAO invoiced CHF 268,144 for its 2012 annual review and the 2013 mid-term review of the entire ETH Domain.

Internal control system
The institutions of the ETH Domain have an internal control system, which was introduced in line with Federal regulations. The SFAO can thus audit the accounting system and finance-related business processes using the same methods as for other Federal institutions or private-sector enterprises of comparable size.

ETH Board support

Internal Audit
The ETH Board employs Internal Audit staff (as per Art. 35a of the ETH Act), who report directly to the President of the ETH Board.
- Patrick Graber, Head

Staff of the ETH Board
The ETH Board's staff support it in fulfilling its legal mandate, particularly regarding strategic leadership, supervision, promotion of cooperation in the ETH Domain and liaising with the Federal authorities.

Executive Team
- Dr Michael Käppeli, Executive Director
- PD Dr Kurt Baltensperger, Science
- Markus Bernhard, Communication (until 31.10.2013)
- Dr Dieter Künzli, Finance
- Dr Urs Müller, Legal Services
- Michael Quetting, Real Estate
- Martin Sommer, Human Resources

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

Guidelines concerning secondary occupations
The ETH Board has adapted its guidelines regarding the procedure for assessing secondary occupations exercised by members of the Executive Boards of the two Federal Institutes of Technology and members of the directorates of the four research institutes of 15 October 2012 in line with the new statutory provisions on personnel set out in the ETH Domain Ordinance of 19 November 2003 (new Article 7a) and the Personnel Ordinance for the ETH Domain of 15 March 2001 (new Article 56a).

Appendix 2: Additional Material to Chapter A

Table 1a: Success stories for collaboration with industry: ETH Zurich and EPFL (referring to chapter A.1.2)

ETH Zurich	EPFL
"As ETH Zurich is convinced, Technology transfer is no longer a one-way street from academia to industry, but rather an equal exchange whereby both parties are mutually inspired and new visions are jointly materialized to face major societal and global challenges. A perfect example for this are the so-called *Lablets*, small company research units set up near the universities' campus. The Disney Research Center at Zurich is one such Lablet that was established in a small building on the ETH campus in 2009. Research at the Disney Research Center in Zurich is carried out in close collaboration with ETH Zurich in various research areas such as capture technologies, postproduction video processing for the film industry, human and facial animation for films and computer games as well as sensor technology and robotics. Collectively, the publication output has increased substantially, more than 180 individual projects were launched and dozens of patents have been registered. The Disney Research Center in Zurich currently has more than 60 employees, many of them doctoral students from ETH Zurich. And as a result of this growth a new facilty has been built next to the ETH Zurich campus."	"With its *Innovation Park*, EPFL has set up a successful infrastructure for attracting research centers of companies, their business units with innovation cells or their R&D teams directly on the EPFL campus. This has created unique opportunities for mutual stimulation as well as most valuable synergies, from which both the industry partners and EPFL benefit greatly. Innovation Park clearly represents the most accomplished partnership with companies and enables further strengthening of EPFL-industry links. It currently hosts 13 corporates and more than 110 start-ups, with about 2,000 high value added jobs. EPFL Innovation Park has a 95 % occupancy and proves to be profitable for EPFL. Mutual benefit is created, among others, through the following advantages the Innovation Park presents: – Companies can directly benefit from the proximity of EPFL researchers; – EPFL enables them to make use of its research infrastructure, so that they can explore new fields and engage in "open innovation"; – students benefit from practice-oriented training opportunities; – start-ups can continue to benefit from strong links to EPFL from the outset. Furthermore, in order to foster relations within the companies installed on campus, a specific offer has been developed. As an example, collaborators working for companies at Innovation Park have the opportunity to – update their technical skills by following Master courses; – think "out of the box" by organizing focus groups with students; – or discover start-up activities through specific networking events. In terms of examples of established industrial corporates, 2012 and 2013 have seen the inauguration of the Nestlé Institute of Health Sciences and the arrival of Nitto Merck Serono and ViaSat on EPFL campus, in 2014, Bühler and Axa."

Table 1b: Success stories for collaboration with industry: ETH Zurich and EPFL (referring to chapter A.1.2)

PSI	WSL	Empa	Eawag
"Nowadays, *Ampegon* (located at Turgi) is one of the key players worldwide as provider for RF amplifier systems and high-voltage power supplies for large-scale research facilities. This success story started due to the cooperation between PSI and Ampegon during the design and construction phase of the Swiss Light Source (SLS) end of the 1990s. Based on the gained competences, the know-how transfer and the world-class reference of the SLS, the company was able to establish itself in the highly specialized market of accelerator research labs. Meanwhile Ampegon sold more than 40 supply units and modulators worldwide. The company is presently involved in the development of the modulator system for the European X-FEL project (Hamburg, Germany), the European Spallation Source ESS (Sweden) and of the short pulse modulators for the PSI's X-ray laser SwissFEL. The latter project has again the potential to position Ampegon as a leading manufacturer of this technology in the international research community."	"An example of industry collaboration, in which WSL has recently been involved, is *NESSy*. NESSy is a new energy-efficient snowgun system developed by the Swiss company Bächler Top Track in close collaboration with the SLF branch of WSL, as well as with the University of Applied Sciences North-western Switzerland. Through a three year research project supported by the CTI, it has been possible to develop a system for artificial snow production that sets new standards in terms of energy efficiency. Through field tests in a climate controlled wind tunnel with a detailed theoretical model, the entire process could be better understood and optimized. As a result, artificial snow can now be produced with no additional energy input beside water pressure. The newly developed system also allows snow making at a 2° C higher temperature than usual and is less affected by higher water temperatures. In addition, through improved nozzle technology and the reduced air pressure, NESSy produces very low noise emissions and presents, therefore, additional advantages for users and the public at large."	"In order to improve patient safety against bacterial infections, *bacteria-repellent surface coatings* are often used in medical engineering. As body odors can also be caused by bacteria, treating textiles in a similar way should prevent the unwanted development of odors, which was the goal of a project supported by the Commission for Technology and Innovation (CTI), in which Empa has collaborated with SANITIZED AG and Swissatest Testmaterialien AG. The result has recently entered the market: the Sanitized® Pluma technology. The textile fibers are coated with a special polymer that holds a microscopically thin film of water on the fiber's surface. This prevents bacteria from docking onto the textile, and any bacteria that are already present can simply be washed away, either by hand or by machine wash at low temperatures, which saves energy and water and prolongs the service life of the textiles. The innovation recently won the Swiss Technology Award 2013."	„Eawag has fruitfully cooperated with the Bill and Melissa Gates Foundation, after it had been awarded a prize of the foundation within the scope of their international competition called *„Re-Invent the Toilet Challenge"*. The objective of this initiative is to bring sustainable and affordable sanitation services to urban slum neighborhoods in low-income countries with a toilet that has to recover all resources. In addition, the toilet should operate grid-free (not be connected to an electricity grid, piped water, or sewer), with total costs not exceeding 5 US cents per person and day. To this end, an Eawag team has developed a holistic sanitation system ("Blue Diversion"), that works across the entire sanitation value chain from capture, storage and transport to reuse of resources. Thanks to a new generation urine-diverting toilet, undiluted urine, faeces, and used flush-and-wash water can be separated. This enables efficient resource recovery, as the used water can be treated in a multi-barrier treatment system and be reused on-site. The resources of the urine and faeces can be recovered off-site, where fertilizers can be produced. In order to ensure safe and reliable disposal of the urine and faeces at an affordable price, the team has also developed a profitable business model that will be interesting for local entrepreneurs."

Table 2: Activities for fostering entrepreneurship and the foundation of Spin-offs (referring to chapter A.1.4)

ETH Zurich

ETH Zurich aims at fostering the entrepreneurial spirit of its students from a very early stage through their entire parcours at the school. Various programs and projects are implemented to this end:

- Generally, ETH Zurich offers a broad range of teaching in the field of *management*, in particular with its Department of Management, Technology and Economics (D-MTEC).
- Furthermore, students are involved in so-called *Focus Projects*, where a group of students from various engineering and science background have to solve a technical problem or develop a prototype within one year.
- Every spring, the best invention of the previous year is elected and awarded with the *Spark Award*.
- Students – usually at the Master, PhD or PostDoc level – with outstanding research results or promising technologies and an entrepreneurial mindset as well as a clever business idea, can, twice a year, apply for a *Pioneer Fellowship*. If granted, the Pioneer Fellows will receive 150,000 CHF which should take them through the next about 18 months to further develop the technology. In addition, the Pioneer Fellows are also assisted by professional coaches from industry or by serial entrepreneurs. 10-15 such fellowships are granted every year.
- The Pioneer Fellows (as well as spin-offs in their very early phase for up to two years) are hosted in the *Innovation & Entrepreneurship Lab* (ieLab). The ieLab is complementing the science-oriented institutes of ETH Zurich with a second, entrepreneurial home for like-minded talents. It provides an interactive, team-based working environment for these Fellows, where they are supported in the development of their innovative ideas by their peers and by experienced professionals. The ieLab offers office space, meeting rooms, workshops and laboratories. Two different "biotopes" are currently in operation, for engineering and ICT (micro/nano-electronics, robotics, automation, photonics, information and communication technology etc.) and for life sciences (biochemistry, pharmaceutics, biotechnology, etc.).
- Continuous entrepreneurial education is achieved by three measures: 1) In the weekly ieLab Lunch Seminar series, experienced professionals relate current problems and best business practices of all aspects of today's entrepreneurial life. 2) The Fellows are made aware of the many existing courses covering most aspects of entrepreneurship, offered for example by D-MTEC, CTI, Technopark, VentureKick, VentureLeaders, etc. 3) Specialized training that cannot be found elsewhere is organized for the ieLab's young talents (e.g. negotiation skills, enhancement of legal knowledge, etc.).
- The activities of the ieLab are effectively complemented by events such as:
  - Regular networking and partnership events including the ETH Industry Days,
  - the Meet-the-Pioneer evening and Home-Coming Dinners including all former ETH spin-off companies that have developed into successful ventures,
  - access to powerful networks of national organizations supporting entrepreneurship (Venture Business Plan Competition, CTI Start-up, Institut für Jungunternehmen, Venture Leaders, Venture Kick, Venture Business Plan competition, US Entry Camp, etc.),
  - access to potent financing networks (SECA, CTI-Invest, ZKB, business angels and venture capital investors) as well as local incubator/business-park type Infrastructure (BlueLion, Technopark, BioTechnopark, etc.) complementing the entrepreneurship ecosystem.
  - ETH Zürich's effort has led to a continuous flow of new spin-offs – more than 20 every year for the last 8 years – that are frequently awarded with prestigious prizes (e.g. Swiss Economic Award), rank among the most promising ventures in Switzerland, attract on a consolidated basis up to 100 million of national and international investments in a year and become either highly sought-after acquisition targets of big corporates or highly successful stand-alone Swiss companies.

Table 2 (continued): Activities for fostering entrepreneurship and the foundation of Spin-offs (referring to chapter A.1.4)

EPFL	Research Institutes[76]
EPFL attaches great importance to the fostering of entrepreneurship and has developed a wide range of support initiatives and programs serving this end: – Students are encouraged to discover entrepreneurship through *courses and conferences*. The College of Management of Technology (CDM) is responsible for the courses offered as electives at the bachelor level, as well as for the Master in Technology and Entrepreneurship (MTE) and the Executive MBA in Management of Technology (MOT). – The Vice-presidency for Innovation and Tech Transfer (VPIV) co-organizes the *ventureideas* cycle of conferences which invites twice a year high-tech entrepreneurs who share their experience with the EPFL community. – VPIV also manages the *Innogrants*. Since 2005, 70 grants (of 100,000 CHF) out of more than 500 applications have helped in the creation of more than 45 spin-offs. – VPIV's TTO (Technology Transfer Office) further structures the licenses of technology to its spin-offs and recently launched the *Enable program* to accelerate the proof of concepts of technologies. Master students are invited as interns for the program. – VPIV finances a *coaching program* to help its staff and students interested in creating a start-up. The CTI coaches based at the Innovation Park advice and mentor these future entrepreneurs. – VPIV also recently launched a new co-working accelerator, *La Forge*, where these new entrepreneurs can work on their projects, meet and learn from their peers and receive the support of this rich entrepreneurial ecosystem. At La Forge, bimonthly workshops are organized there between entrepreneurs, investors and service providers. – VPIV heavily sponsors the *ventureleaders* program, which selects 20 promising young entrepreneurs to discover the Boston innovation ecosystem. It also encourages and contributes to the BCV's Silicon Valley Camp. In August 2014, EPFL was awarded funding from Erasmus+ together with the 3 other universities of the Eurotech consortium to build an equivalent European Venture Program. These efforts are part of an ambition to expose entrepreneurs as early as possible to markets and in particular to its international angle, thanks to partnerships with the local Swissnex houses. – In collaboration with the EPFL Innovation Park, VPIV further supports the 10–20 spin-offs created each year by helping them in their development through multiple support tools such as the *FIT foundation*, *Prix Vittoz* and other entrepreneurial prizes. As a result, EPFL spin-offs have raised more than 600 MCHF from private investors in the last 10 years and enjoyed three trade sales in the first half of 2014.	*PSI* encourages its scientists to exploit inventions, which may develop into spin-off companies: – Products with this potential are primarily invented, as "fruits" of fundamental research, for proper needs and later adapted for other markets (detector technology, proton therapy, transport systems for particles, energy relevant devices, undulator technology, high-frequency devices, etc.). – As an example, Dectris, founded as a spin-off company of the PSI, was the first company worldwide to sell innovative hybrid-pixel X-ray detector systems and is now the world market leader. This technology features a very high dynamic range, a short readout time and excellent signal-to-noise ratios improving quality and throughput of the measurements. The detectors can be used in various areas such as synchrotron light sources, laboratory diffraction systems or industrial and medical applications. Before commercialization of the next generation pixel detectors developed at the PSI, the prototypes can be used exclusively on in-house large-scale research facilities, which gives a significant competitive benefit for the PSI beamlines. The underlying technology evolved from basic research initially developed for particle physics. *Empa* fosters about two to three new start-ups each year through its two business incubators, i.e. glaTec Dübendorf and tebo in St. Gall, the latter closely tied to the STARTFELD initiative in Eastern Switzerland. The majority of these start-ups are over-average successful, attested by the various prizes they win and the financing they are able to secure. – In 2013, for instance, around 100 experts ranked the glaTec company QualySense, which develops robots to quality inspect and sort grains, seeds, and beans, in tenth place out of the top 100 start-ups in Switzerland. – Another glaTec company, Compliant Concept (intelligent bed systems for the treatment and prevention of pressure ulcers), came in 34th. – The Empa spin-off Monolitix, finally, which specializes in compliant mechanisms, was shortlisted for the prestigious De Vigier Award 2013, made it to the final of the Heuberger Jungunternehmerpreis 2013 and reached the final (top three) for the ZKB Pioneer Award 2014.

[76] Given the nature of their main focus (public goods), both WSL and Eawag do not dispose of particular activities or programs to be enumerated in this table, as their areas of specialization due to their very nature do not yield inventions with commercial potential. However, they fully endorse the entrepreneurial spirit cultivated within all ETH Domain institutions.

Appendix 3: Additional Material to Chapter F.1

Statement of the ETH Board on the Implementation of the Experts' Recommendations of the 2010 Intermediate Evaluation

	Recommendation	Status and explanation
1a)[77]	*The ETH Domain is an increasingly important asset to Switzerland and an excellent concept that should be maintained and further developed.*	*Recommendation implemented* Implementation of this recommendation is not in the hands of the ETH Domain. But the ETH Board – in its strategic controlling function – frequently emphasizes collaboration of the institutions to further strengthen this unique association of autonomous education and research institutes and to make effective use of the financial means granted from the Swiss Confederation. The complementary competencies and offerings generate added value for researchers and students in the ETH Domain and for the entire Swiss education and research landscape.
1b)	*Complementarity within the Domain is paramount. Incentives for collaboration among the partners should be implemented and continued to drive the one Domain to even higher levels of excellence.*	*Recommendation implemented* Collaboration among the ETH Domain institutions, including the Competence Centers, has been fostered and strengthened over the past years. This applies also to the large research infrastructures through their user facilities concept (e.g. hosting of the supercomputer at CSCS for EPFL's contribution to HBP). Furthermore, joint professorships between ETHs and RIs represent important instruments for strengthening cooperation. However, as stated in its Response to the Peer Report (2010, p. 6), the ETH Board maintains that in strategic areas "a critical mass, including a healthy degree of overlaps and competition are good drivers for excellence".
1c)	*The Domain should strive for a Domain branding for Switzerland while respecting the strong international brands of the partners.*	*Recommendation not implemented after intense preparations* In the 2010 intermediate evaluation, the peers suggested that the ETH Domain should "strive for a Domain branding for Switzerland while respecting the strong international brands of the partners." As the ETH Board stated in its response to the Peer Report, a process destined at creating a common brand for the entire ETH Domain had been launched in 2009. After intensive work, including an internal consultation process within the ETH Domain institutions on a concrete proposal of the ETH Board, it was decided to discontinue the branding project in December 2012. As the ETH Board's final report on the performance period 2008–2011/12 states, the following steps have been undertaken in the meantime: – In summer 2009, the ETH Board decided to further develop a project that would allow the ETH Domain institutions to maintain their strong individual brands, which will be supplemented by a common by-line referring to the Domain ("endorsed brand model"). – Between 2009 and 2010, a "Communications Framework for the ETH Board and the ETH Domain" analyzed and documented potential solutions, including the view of stakeholders, politicians and media, and drawing also on the international perception of the ETH Domain. – As mentioned by the ETH Board in its response to the Peer Report of 2010, five fields of action for reinforced communication were designated, one of which focuses on the development of a common brand. – Subsequently, and despite the reservations expressed within some institutions, the ETH Board together with representatives of the ETH Domain institutions has developed a common brand. The brand has been protected internationally. – During 2012, a formal consultation (as requested by the ETH Act) was held within the ETH Domain. This consultation was also addressed to internal bodies – such as the University Assemblies of ETH Zurich and EPFL or the Internal Appeals Commission – who had not yet been involved in the previously confidential process. – The consultation revealed that both Federal Institutes of Technology were – for different reasons – opposed to the proposed brand. At its meeting in December 2012, the ETH Board discussed the results of the consultation in detail. Based on the results of the consultation, it acknowledged that no consensus between the diverging needs and positions of the ETH Domain institutions could be reached. – On these premises, balancing the interests and chances of success, and in light of its current priorities, the ETH Board decided to abandon the ETH Domain branding project.

[77] The numbers attributed to the individual recommendations refer to the numbers structuring the ETH Board's Response to the Peer Report on the 2010 Intermediate Evaluation.

Statement of the ETH Board on the Implementation of the Experts' Recommendations of the 2010 Intermediate Evaluation (continued)

	Recommendation	Status and explanation
2a)	*There has been a dramatic increase in performance of the Domain with a very strong scientific reputation, and we commend the leadership of the individual partners. However, to continue to monitor and increase the Domain's international positioning, we highly recommend the establishment of an international advisory board to the ETH Board.*	*Recommendation not implemented after thorough examination* As announced in its response to the Peer Report, the ETH Board studied the options for establishing an international advisory board. It considered the possibility of constituting a small board comprising members of existing advisory boards at the individual institutions who are familiar with the ETH Domain. – However, such international advisory boards and/or research commissions exist at ETH Zurich and EPFL as well as at the Research Institutes and are considered most valuable for the individual development of these institutions. – After examining this option, the ETH Board therefore came to the conclusion that an advisory board additional to the ETH Board would result in unnecessary and potentially conflicting redundancies. – Furthermore, the periodic evaluations with international expert panels of entire institutions or their units – as performed by the institutions on a regular basis – were considered to be much better positioned for providing the intended international perspective. – The institutions are required to bring these evaluations to the attention of the ETH Board, which gives the ETH Board valuable insights into the appraisal of the institutions' activities and strategies with regard to their international positioning. – Therefore, the nomination of an additional international advisory board has not been pursued by the ETH Board.
2b)	*Part i) To internationalize, the Domain has recruited top-level international faculty. In a competitive international environment the Domain has successfully recruited a global student body. However, selection criteria have to be refined at entry and at the Master's level.*	*Recommendation implemented* The ETH Board has decided to suggest an amendment of the ETH Act allowing, with regard to students with a foreign entry qualification, to restrict access to higher semesters of the Bachelor level or the Master level in a particular area of studies for capacity reasons if quality of education would be jeopardized. This amendment has been included in the ERI Message 2013–2016 and has taken effect as of January 1, 2013. The ETH Board has decided at its meeting of September 17/18, 2014, to request, together with the ERI Message 2017–2020, an amendment of this provision. With this amendment, the ETH Board shall be enabled, upon request of the two schools, to restrict access to a particular area of studies also at the entry level to the Bachelor degree. Still, this restriction would only apply to students with a foreign entry qualification. As stated in the ETH Board's response to the peer report, it is impossible to include Swiss students in this regulation, as the Swiss "Matura" guarantees access to all fields of study.
	Part ii) The ETH Board should monitor the continuing internationalization of the Domain and ensure that there are policies and practices in place at global standards to attract and retain quality staff and students.	Both ETH Zurich and EPFL have continued to grow with regard to the number of foreign students enrolled at one of the two schools. In particular with regard to the origin of the PhD students, a growing internationalization proves the high attractiveness of the ETH Domain institutions (the share of foreign PhD students exceeds 75 % both at ETH Zurich and at EPFL). Furthermore, the ETH Board regularly discusses and monitors – both in regular meetings and in the yearly Dialog meetings with the individual institutions – the strategies for internationalization and the respective experiences of the ETH Domain institutions. In particular, this applies to the Singapore-ETH Centre SEC (at Singapore) of ETH Zurich, and to EPFL Middle East at Ras-al-Kaimah (UAE), They were founded in 2010 and 2009, respectively, and shall be further developed in the coming years, guided by the International Strategy of the ETH Domain, which is currently under preparation by the ETH Board.

Statement of the ETH Board on the Implementation of the Experts' Recommendations of the 2010 Intermediate Evaluation (continued)

	Recommendation	Status and explanation
2c)	*The institutions of the Domain have excellent, international-standard research profiles. However, we recommend that the balance of research increasingly shift toward third-party-funded research.*	*Recommendation implemented* All ETH Domain institutions have been able to increase their part in second- and third-party funding for research over the past years. The following table, taken from the Annual Report 2013, p. 138, shows the evolution since 2007 and in comparison to 2004:

Fig. 36: Project-oriented second-party resources, third-party funding, service revenue and financial result

In m CHF (figures rounded)	2004	2007	2008	2009	2010	2011	2012	2013	Δ2012/2013 absolute	Δ2012/2013 %
ETH Domain consolidated	**419.9**	**530.6**	**549.2**	**608.5**	**645.6**	**796.2**	**798.6**	**822.9**	**24.3**	**3.0**
ETH Domain consolidation	– 0.2	– 6.7	– 7.9	– 6.7	– 9.4	– 14.7	– 14.3	– 13.9	0.5	– 3.2
Changes in second-party resources and third-party funding	– 34.0	– 21.4	– 149.3	– 95.0	– 108.6	– 52.3	– 99.4	– 37.0	62.4	– 62.8
ETH Domain	**454.2**	**558.7**	**706.4**	**710.2**	**763.6**	**863.2**	**912.3**	**873.8**	**– 38.5**	**– 4.2**
Second-party resources	**241.6**	**279.0**	**323.8**	**372.5**	**408.5**	**445.2**	**477.3**	**453.6**	**– 23.7**	**– 5.0**
Third-party funding	**104.3**	**146.9**	**230.5**	**188.3**	**210.3**	**212.6**	**292.7**	**263.8**	**– 28.9**	**– 9.9**
Service revenues	**97.4**	**116.3**	**144.4**	**136.4**	**137.5**	**195.4**	**129.4**	**143.3**	**13.9**	**10.8**
Financial result	**10.8**	**16.5**	**7.8**	**13.1**	**7.3**	**10.0**	**12.9**	**13.1**	**0.1**	**1.1**
ETH Zurich	**198.6**	**268.6**	**311.0**	**319.6**	**356.4**	**362.0**	**428.1**	**417.3**	**– 10.8**	**– 2.5**
Second-party resources	100.4	131.9	131.1	167.7	190.2	195.0	211.2	211.1	– 0.1	– 0.1
Third-party funding	46.7	70.3	112.2	80.4	93.9	83.7	141.2	124.3	– 17.0	– 12.0
Service revenues	46.0	57.7	67.0	64.0	66.6	76.7	68.6	73.9	5.3	7.7
Financial result	5.4	8.7	0.8	7.6	5.8	6.6	7.1	8.1	1.0	14.5
EPFL	**140.6**	**162.9**	**241.7**	**221.7**	**245.5**	**263.5**	**270.0**	**258.8**	**– 11.2**	**– 4.1**
Second-party resources	91.1	88.3	131.6	127.3	136.7	159.7	162.3	148.1	– 14.2	– 8.7
Third-party funding	17.8	40.2	63.6	56.3	72.7	72.0	75.5	75.9	0.4	0.5
Service revenues	28.6	30.6	42.2	34.3	34.6	29.2	29.8	31.7	1.9	6.3
Financial result	3.1	3.8	4.3	3.9	1.4	2.6	2.5	3.2	0.7	29.4
PSI	**49.6**	**55.6**	**74.9**	**80.9**	**73.1**	**137.0**	**109.6**	**89.8**	**– 19.8**	**– 18.1**
Second-party resources	14.7	22.2	18.0	23.7	28.4	33.2	38.7	28.1	– 10.6	– 27.4
Third-party funding	26.7	19.9	36.2	35.6	23.9	36.1	55.6	42.6	– 13.0	– 23.4
Service revenues	6.5	11.9	19.1	20.7	20.2	67.3	12.1	17.7	5.6	46.4
Financial result	1.7	1.6	1.6	0.8	0.6	0.4	3.3	1.5	– 1.8	– 55.5
WSL	**18.6**	**16.8**	**20.9**	**22.7**	**23.1**	**25.1**	**24.5**	**27.1**	**2.6**	**10.6**
Second-party resources	14.0	10.7	13.9	16.7	16.8	18.1	17.6	20.9	3.3	19.0
Third-party funding	3.2	4.1	5.2	4.5	5.1	4.7	4.6	3.3	– 1.3	– 27.9
Service revenues	1.4	1.5	1.5	1.5	1.5	2.3	2.3	2.8	0.4	19.2
Financial result	0.1	0.4	0.3	0.0	– 0.4	0.0	0.0	0.1	0.1	288.3
Empa	**36.7**	**40.9**	**43.3**	**51.4**	**49.4**	**56.7**	**62.0**	**63.5**	**1.6**	**2.6**
Second-party resources	14.6	17.8	20.4	27.3	26.0	26.8	35.5	34.8	– 0.7	– 2.0
Third-party funding	7.4	8.9	8.6	8.7	10.7	11.8	10.6	12.0	1.4	13.3
Service revenues	14.2	13.3	13.9	14.8	12.9	18.1	15.8	16.6	0.8	4.8
Financial result	0.5	0.9	0.3	0.5	– 0.2	– 0.0	0.0	0.1	0.1	409.7
Eawag	**10.0**	**13.2**	**14.6**	**13.9**	**16.1**	**18.7**	**18.1**	**16.5**	**– 1.6**	**– 8.7**
Second-party resources	6.8	8.1	8.8	9.9	10.5	12.4	12.0	10.6	– 1.4	– 11.6
Third-party funding	2.5	3.5	4.8	2.8	3.9	4.2	5.3	5.1	– 0.2	– 3.6
Service revenues	0.6	1.0	0.6	0.9	1.6	1.8	0.7	0.7	0.0	0.0
Financial result	–	0.6	0.3	0.3	0.2	0.3	0.0	0.1	0.0	33.6
ETH Board	**0.0**	**0.7**	**0.2**	**0.0**	**0.1**	**0.0**	**0.0**	**0.7**	**0.7**	**–**
Service revenues	–	–	–	–	–	–	–	–	–	–
Financial result	–	–	–	–	–	–	–	0.7	0.7	–
Service revenues	0.0	0.3	0.1	0.0	0.0	**0.0**	**0.0**	**0.0**	**–**	**0.0**
Financial result	–	0.4	0.1	0.0	0.0	**0.0**	**0.0**	**0.0**	**–**	**0.0**

Statement of the ETH Board on the Implementation of the Experts' Recommendations of the 2010 Intermediate Evaluation (continued)

	Recommendation	Status and explanation
2c)	*continued*	The share of second- and third-party funds (including service revenues) in the total income of the ETH Domain has increased from approx. 20 % in 2004 to approx. 26 % as projected for 2015. On the level of the individual institution, its share depends much on the institutions' general orientation and its specific tasks. It therefore varies between approx. 20 % and approx. 35 % (source: Budget Report 2015). In its response to the Peer Recommendations 2010, the ETH Board has declared that it endorses the strategy to increase second- and third-party funding, but that it advocates only a moderate growth rate in second-party funding. This is explained on the one hand by the problem of insufficient coverage of indirect costs (see statement regarding recommendation 5c). On the other hand, the ETH Board has also put forward "political and cultural" constraints to further increase second- and third-party funding, i.e. the fact that any increase of the share of ETH Domain institutions in the SNSF funds will diminish the proportion of funds allocated to cantonal universities and universities of applied sciences if the SNSF budget is not increased accordingly. The ETH Domain institutions however, have been very successful in attracting second party funding from European funding sources, in particular through the ERC grants' scheme.
2b)	*Part i) To internationalize, the Domain has recruited top-level international faculty. In a competitive international environment the Domain has successfully recruited a global student body. However, selection criteria have to be refined at entry and at the Master's level.*	*Recommendation implemented* The ETH Board refers to the chapter A of the present Self-Assessment report, developing on the instruments and the successful positioning of the ETH Domain with regard to Knowledge and Technology Transfer and its contribution to innovation performance in Switzerland. In response to the peer group's recommendation, the ETH Board has mandated a working group to improve transparency on existing KTT activities, support exchange of best practice in the Domain, consolidation of specific competencies, mobilize industrial stakeholders, and to prepare coordinated action according to need. The institutions have further professionalized their KTT agencies, have intensified their collaboration with external KTT actors, and have developed new instruments for collaboration with private companies (cf. chapter A.1 above). This has contributed, among other things, to an increased collaboration and closer exchanges with facilitators from industry, namely Swissmem or Swiss Biotech. The ETH Domain's increased performance in the field of KTT is reflected in the increase of patent applications, licenses and spin-offs (see figure 2 on p. 29). Furthermore, it is underlined by the fact that income from third-party funds has doubled since 2007. Given the evolution of KTT activities at the individual institutions, no particular action with regard the policy or the regulation level was deemed necessary to be taken by the ETH Board. Rather, the ETH Board is convinced that the good practices policy applied, with regard to the institutions' KTT activities, in the past has proved to be a successful approach and needs to be maintained.
3a)	*The Domain is on its way to assume world-wide leadership in the field of science-based technology and engineering, supported by the five key focus areas as outlined in the strategic planning 2012-2016. The increased world-wide emphasis on research at the interface of medical science and engineering will require the Domain to establish strong relationships with medical schools to allow that collaborative research and education be effective.*	*Recommendation implemented* As stated in the chapter on the role and the activities of the ETH Domain in the field of medical science and medical technology included in the present Self-Assessment report (cf. chapter D above), the ETH Domain plays an increasingly important role in all these fields. It is implementing a strategy that focuses on intensifying the existing collaboration with (academic) partners (universities and hospitals) in order to strengthen Switzerland's capacities in the field of translational medical research. Medical science and technology will continue to constitute a focus area of the ETH Domain. It has been anchored in the Strategic Planning 2017-2020 of the ETH Board for the ETH Domain (Strategic focus area "Personalized Medicine and medical technology").

Statement of the ETH Board on the Implementation of the Experts' Recommendations of the 2010 Intermediate Evaluation (continued)

	Recommendation	Status and explanation
3b)	*Focus is critical to achieve global excellence. Play to your strengths, which include collaboration within the Domain toward research excellence. In this regard, the Competence Centers have been a very good place to start. We recommend allocating a portion of the budget in a competitive fashion, to encourage collaborative research.*	*Recommendation examined but not implemented* As already stated in its response to the peer recommendations, the ETH Board continues to believe that it is not in a position nor would it intend to take up an active role in the competitive promotion of research. Therefore, it has stated in 2010, that the recommendation can only be partially consistent with its strategy. The ETH Board still funds the four Competence Centers of the ETH Domain, which in turn grant funding to projects on a competitive basis. In these cases, however, funding decisions are made by the Competence Centers, not by the ETH Board. With regard to competitive funding in general, the statement of the ETH Board issued in 2010 remains entirely valid: "To a large extent, the ETH Domain is already focused on competition as a result of its previous efforts to mobilize external funding and in future such efforts will continue to be limited to second- and third-party funding. In addition, the ETH Board as a body is unable to assume any role in the promotion of research as it lacks the required legal competence and professional expertise to assess research applications. That role rests with the internal (institutions) research commissions and external (e.g. Swiss National Science Foundation) competitive funding agencies." *See additionnally the answer regarding recommendation 6a), developing the LEI0MIZU concept.*
3c)	*The Committee was impressed and supportive of the excellent funding that the Domain has received from the nation. Strong federal support must continue, while at the same time the Domain must seek economic efficiencies and second- and third-party funding.* *While the Domain has made important improvements in third party financing in recent years, it will be critically important for the Domain to encourage continued improvement in this area. The difference between good performance and great performance will come with increased third party funding.*	See answer regarding recommendation 2c)
4a)	*We were impressed with the quality of the work of the existing ETH Board and feel that it is imperative that this emphasis on quality continue with future appointments to the ETH Board. However, a global University requires a globally connected governance structure. The chair of the international advisory board (recommended in section 2a) should be a regular member of the ETH Board.*	*Recommendation not implemented after thorough examination* Closely linked to the considerations presented in recommendation 2a) above, the ETH Board concluded that chairing an advisory board and at the same time acting as a member of the ETH Board would generate a workload that would make such a function unattractive for high-caliber individuals. – The members of the ETH Board spend at least ten days at regular meetings and six days in the annual dialogs with the institutions of the ETH Domain. – A (national) Board member who would have to chair the international advisory board would have to spend additional time for this function. If that member were to be an international member, the substantial amount of travel time would put an even larger burden on him or her. – This view has been confirmed by the experience of trying to appoint an international regular member of the ETH Board. The search of such a regular board member had to be terminated as it became clear that potential candidates considered they would have to spend too much time travelling just in order to be able to attend the regular board meetings. – Given the conclusions drawn with regard to the nomination of an international advisory board and taking into account this experience, the ETH Board has deemed it inappropriate to follow up on the appointment of an international board member (even if this member were not to be considered as the chairman of an international advisory board). See also answer regarding recommendation 2a)

Statement of the ETH Board on the Implementation of the Experts' Recommendations of the 2010 Intermediate Evaluation (continued)

	Recommendation	Status and explanation
4b)	*In order to be responsive to the ever-changing research and education needs of society the Domain needs to own and manage its real estate and facilities.*	*Recommendation examined but not implemented* As stated in its response to the Peer Report, the ETH Board welcomed this recommendation and took up "the issue of working towards the long-term goal of transferring real estate into the ETH Domain in its Action Plan for 2011". Hence the advantages and disadvantages of a transfer of ownership of real estate were carefully assessed by the ETH Board. In parallel, negotiations with the Swiss Confederation as the owner resulted in substantially improved flexibility in the usage of the Confederation's real estate within the ETH Domain: – The ETH Board's competency has been extended, allowing the transfer of up to 20 % of the budget for investments to the *"Finanzierungsbeitrag"*, i.e. the Confederation's financing contribution covering operating expenses. – The ETH Board was further granted the option of transferring credit to the following year if needed, plus the possibility of re-investing revenues from real estate sales and applying alternative financing models involving private parties. – Considering these substantial improvements, the ETH Board decided in December 2011 to put further attempts to transfer ownership of real estate to the ETH Domain on hold. In doing so, it also sought to avoid the significant disadvantage of assuming liability and other potentially costly duties incumbent upon a real estate owner.
4c)	*We have considered some of the alternative proposals for the Research Institutes, including the question of whether some or all of them should be merged into the universities. The committee feels that the present organization is appropriate.*	*Recommendation implemented* The ETH Board shares the view expressed in the 2010 intermediate evaluation. The position of the Research Institutes has been further strengthened over the past years. The Competence Centers of the ETH Domain strongly contributed to the interaction between the ETHs and the Research Institutes, as well as additional joint professorships. In addition, each of the directors of the Research Institutes hold full professorships with ETH Zurich and EPFL.
4d)	*The Research Institutes appear to be well led. Their performance is good and getting better according to the evidence received, and their contribution in teaching is at an appropriate level.*	*Recommendation implemented* The ETH Board shares the view expressed in the 2010 intermediate evaluation. The position of the Research Institutes has been further strengthened over the past years. The number of teaching hours of the Research Institutes has been stabilized at a high level.
5a)	*The financing of the Domain has been comparatively stable compared to the volatility experienced in other countries. This is a significant strength of the Domain and every effort should be made to continue the stability with significant financial growth to drive excellence. However, the committee believes that for any global university to reach the pinnacles of success, it will be necessary for them to be effective at obtaining increased second and third-party funding. There have been important successes in this regard and further progress will continue to be important to future success.*	See answer regarding recommendation 2c)

Statement of the ETH Board on the Implementation of the Experts' Recommendations of the 2010 Intermediate Evaluation (continued)

	Recommendation	Status and explanation
5b)	*The Domain should establish a system of evaluation and benchmarking to ensure adequate allocation of funding to the education and support of students.*	See answer regarding recommendation 3b)
5c)	*Indirect costs must be fully covered in order to create an incentive for acquisition of second and third party funding and to avoid creating a situation in which educational funds are diminished in order to support indirect cost of research.*	*Recommendation partially implemented* The ETH Board remains attentive to the fact that inadequate coverage of indirect costs in second-party funding represents an important challenge for the institutions and may contribute to setting adverse incentives, in particular with regard to curiosity-driven research (see, for instance, chapter A.2 above). In the context of the ERI Message 2013–2016, it has been possible, thanks to a joint effort of all actors involved, to implement a policy allowing the SNSF to allocate coverage of indirect costs up to an extent of 20 %. Currently, the ETH Board sees little chances of increasing this proportion, but will continue to raise awareness for the crucial importance of adequate coverage of indirect costs. With regard to third-party funding, the policy of the ETH Domain institutions is to require full coverage of indirect costs from project partners.
6a)	*A portion of the funds should be competitively allocated at the level of the Domain to encourage collaboration and entrepreneurship. Federal funding to the six institutions should provide a designated amount of funding that would be allocated on a performance-based, competitive basis and would serve as an incentive to encourage entrepreneurial efforts by the institutions of the Domain.*	*Recommendation implemented* The ETH Board has developed a performance-oriented model for the allocation of federal funds (*"Erstmittel"*) and applied it starting with the budget 2012. The model is based on a set of criteria for ETH Zurich and EPFL and a different set of criteria for the Research Institutes, according to their special missions. The model takes into account the results from the yearly Dialog meetings with the institutions, where collaboration and entrepreneurship frequently constitute part of the evaluation. Collaboration between the ETHs and the Research Institutes is particularly honored in the context of education (Bachelor-, Master-Theses, as well as PhD theses). *See as well answer regarding recommendation 3b)*
6b)	*True global excellence will require additional effort at obtaining second- and third-party funding.*	See answer regarding recommendation 2c)
A1)	*(from "Preamble") One important general recommendation, to which we will return in the various sections of this report, is that the ETH Board and the separate institutions of the Domain increase international benchmarking. [...] Categories for assessment should be determined by the units that would most benefit from the data; that is, the institutions, not the Board, should decide how best to measure what they value. But benchmarking is essential, especially in measuring educational achievement, and the Committee recommends its increased use.*	*Recommendation implemented* Benchmarking serves quality insurance purposes and the communication about achievements and contributions of the ETH Domain to science and society. Such activities were described in the Annual Report of the ETH Board on the ETH Domain 2013, which contains an entire chapter dedicated to this issue. In this chapter, a comprehensive overview on activities has been given, including procedures, as well as frequently or sporadically used instruments that are applied by the institutions to benchmark with other institutions in comparable fields. However, the ETH Board also concluded that no single comprehensive instrument or standard can be applied to all institutions and their activities.

Statement of the ETH Board on the Implementation of the Experts' Recommendations of the 2010 Intermediate Evaluation (continued)

	Recommendation	Status and explanation
A1)	*continued*	Benchmarking in the ETH Domain is carried out through the following instruments and activities (see Annual Report 2013, p. 127):

Evaluations by external experts (peer reviews) of
- ETH Zurich departments
- EPFL faculties
- research institutes (or parts thereof)
- administrative units
- the ETH Domain (and the ETH Board)

Audits by
- the Internal Audit (as part of horizontal audits)
- external auditors (e.g. audits of the institution's quality management system by the Swiss Center of Accreditation and Quality Assurance in Higher Education (OAQ) or the Swiss Federal Audit Office (SFAO))

Benchmarking in teaching
Curriculum development, programme administration in collaboration with leading international universities (IDEA League, IARU, GULF, EuroTech Universities)

Surveys
of graduates after completing their studies (carried out internally and externally by the Federal Statistical Office (FSO)); to ascertain how satisfied employees are with their working conditions

Recruitment and promotion procedures
Professorships, appointing research and administrative staff

Research infrastructures
e.g. the performance of and demand for large-scale research facilities at the Paul Scherrer Institute (PSI); CSCS
→ *For selected benchmarking activities at PSI, see page 131*

Acquisition of funding
for promoting research at national, European and international level (e.g. Swiss National Science Foundation (SNSF), EU research framework programmes)
→ *For selected benchmarking activities at ETH Zurich and EPFL, see page 128 ff., for Eawag see page 133*

Publications and citations
Subject-specific bibliometric analyses
→ *For selected benchmarking activities at WSL, see page 132*

International university rankings
subdivided by region and specialist area
→ *For selected benchmarking activities at ETH Zurich and EPFL, see page 129*

Rankings of specific areas of research
at research institutes and/or universities
→ *For selected benchmarking activities at Empa, see page 133*

The Annual Report 2014 will contain a chapter on the bibliometric analysis executed in the context of the present intermediate evaluation. In the coming years, selected benchmarking aspects will continue to be highlighted in the ETH Board's reports.

Statement of the ETH Board on the Implementation of the Experts' Recommendations of the 2010 Intermediate Evaluation (continued)

	Recommendation	Status and explanation
A2)	*(from "Recommendations – Budget") A third area of potential movement in relation to budget is in the area of student fees. Low fees for international students could be seen to give Switzerland a competitive advantage, especially if international graduates remain in Switzerland, and the Committee recognizes that this is an especially controversial question in relation to Swiss culture. Nevertheless, the Committee again suggests that the Domain look to international standards in relation to fees for students from non-EU countries.*	*Recommendation followed up, political discussion ongoing on the federal level* Upon proposal of the two ETH, the ETH Board has taken, in December 2012, the principled decision to increase tuition fees for all students. It has been decided that these fees shall be gradually increased over a four-years period, achieving the double level of today's fees until 2017. Opposition against these plans came from students and from actors on the federal political level. Several parliamentary interventions have questioned the ETH Board's decision and asked the Federal Government to take measures in order to prevent the decision from being implemented. In March and October 2013, two motions have been deposited at the National Council, aiming at introducing, in the ETH Act, the option to distinguish between Swiss and foreign students and increase fees for the latter (i.e. "Bildungsausländer"), while imposing a maximum for the fees imposed on Swiss residents (i.e. "Bildungsinländer"). The ETH Board has announced to suspend discussion about the general increase of fees in favor of the steps undertaken by parliament. Although the two motions have been rejected by the National Council (respectively retired by its author in one case), the Federal Council has announced to examine the options and the legal framework conditions (international law) for differentiating tuition fees between Swiss and foreign students in the process of the elaboration of the ERI Message 2017–2020. A corresponding amendment of the ETH Act shall be elaborated in close collaboration with the ETH Board and included in the deliberation process regarding the ERI Message.
A3)	*(from "Recommendations – Education") Both schools would benefit if assessment of individual courses and of program quality were standardized across the schools, using newer models of measurement for student learning and not just teaching performance. If the Domain places a priority on educational outcomes, it must find more ways to measure student learning and must share student learning outcomes data with future peer evaluation committees. [...] In addition, and most importantly, the Committee recommends that the Board investigate contemporary rubrics for measuring teaching and learning and move the institutions toward more attention to data-gathering on student learning outcomes.*	*Recommendation followed up but not continued after in-depth discussion* The topic was addressed as a major issue in the context of the yearly Dialogs with ETH Zürich and EPFL in 2011, followed by an update in 2012. An involvement of the ETH Board that would go further than its strategic controlling role was not deemed appropriate, as it appeared that the responsible persons for academic affairs at ETH Zurich and EPFL are fully aware of the importance of assessing learning outcomes. An important indicator for learning outcome is the employability of the students after graduation. Alumni of ETH Zurich or EPFL enjoy highest occupation rates when measured after one year (higher than 96 %).
A4)	*(from "Recommendations – Education") The Committee recommends the collection and presentation of more detailed, descriptive, and useful data in such areas as faculty/student ratio, average class size, faculty teaching load and contact hours.*	See answer regarding recommendation A3)

Statement of the ETH Board on the Implementation of the Experts' Recommendations of the 2010 Intermediate Evaluation (continued)

	Recommendation	Status and explanation
A5)	*(from "Additional considerations") The Committee applauds the Domain's initiatives in relation to improving the conditions that would make employment at the institutions desirable for both men and women. International benchmarking, for example against Sweden, will help in this regard as well.*	*Recommendation implemented* The institutions of the ETH Domain have continued their efforts in promoting diversity and equal opportunity on all levels. For instance, they participate in the "Fix the Leaky Pipeline"-Program for advanced female researchers. In addition, they have further insisted in career planning and have implemented specific regulations for female assistant professors with tenure track, allowing them to suspend the tenure track procedure for up to one year in case of pregnancy. The ETH Board, however, has refrained from defining quota but has formulated goals for the period until 2016: the share of female professors shall be increased by 50 % compared to 2009 and the amount of resources in measures for the promotion of equal opportunity shall be doubled to 0.4 % of the total financial contribution attributed to the ETH Domain by the Confederation. The ETH Board monitors progress with regard to these priorities. ETH Zurich and EPFL have introduced gender monitorings that are targeted to the "leaky pipeline" problem (see Annual Report 2013). They are intended to provide research area-specific information that will allow to define effective measures.

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