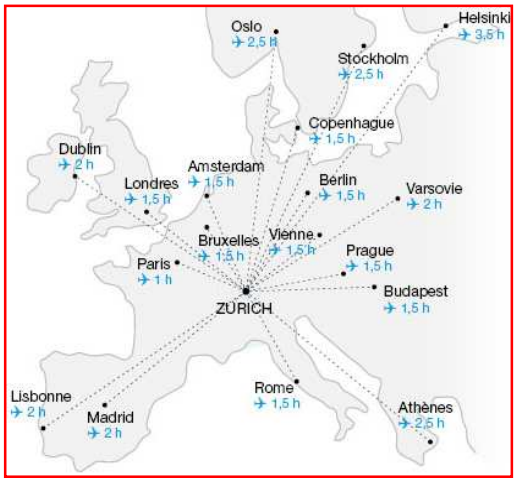
"Science Cities" : Science Campuses and Clusters in 21st Century Metropolises
> Science City in the Zurich 'Wissenshub'


ETH Hönggerberg campus overlooking Zurich agglomeration : © ETH

The national and regional ecosystem of Swiss innovation

Switzerland, a country with virtually no natural resources, has had to find alternative ways to command an international market. It is one of the countries that allocates the highest percentage of its GDP[i] to research and development (R&D), and also boasts the largest proportion of patents per capita.[ii] In 2004, more than 52,000 people were working in R&D. Swiss firms contribute significantly to the national research effort, and their innovation performance alone represents 70 % of the country's R&D expenditure. They are among the world's most innovative companies, and even during a period of economic crisis, they spend 8.7 % of their turnover on R&D. Two Swiss firms are ranked among the world's top ten R&D budgets: Roche and Novartis.[iii]



Zurich is located in German-speaking Switzerland. Although small in size (92 square kilometers), it is nonetheless the country's largest city in terms of population, and is the capital of the canton of the same name. With a population of 380,500, it is a medium-density city (4,070 people/km2), the center of an urban agglomeration numbering 1.1 million residents and including 131 municipalities and three cantons (Zurich, Aargau and Schwyz), with a density four times lower than that of the city.

The greater metropolitan area of Zurich covers five cantons, with a total of 1.7 million residents. Situated in the heart of the European Union, Zurich is linked by the major airport of the Swiss Confederation, as well as by high-speed trains. A leading financial market, Zurich is also a major science pole,[iv] with prestigious universities, teaching hospitals and many high-tech firms, forming a 'metropolitan science park.' Finance and science are therefore the two pillars supporting the economy of this metropolis.

Switzerland's system of university education is fairly decentralized with a dozen of cantonal universities; a dozen specialized public schools (Universities of Applied Science); the Federal Institutes of Technology in Lausanne (EPFL) and Zurich (ETH). Founded in 1855, ETH has become the model for graduate science education in Switzerland and holds an enviable position in international rankings.[v] The federal government funds 80 % of its budget (€830 million in 2008). It is extremely international in scope: 2/3 of the doctoral candidates and more than 50 % of the professors are foreigners. It now has 15,000 students (an increase of 20 % in five years), and 6,700 employees, working on two separate campuses: Zentrum and Hönggerberg.

Science City: the university and building projects for ETH Zurich

▪ Campus features and amenities

'Science City' is the generic name for ETH's scientific development and building project on the Hönggerberg campus. Occupying 32 hectares (79 acres) in the Höngg district, 5 kilometers northwest of downtown Zurich, this campus is situated on the top of a hill amid fields and a forest open to the public, overlooking the Limmat Valley. It takes about 30 minutes to reach the campus via public transport from the main train station, located merely 4.5 kilometers away. As there are no dormitories, no one lives on the campus, and only 4 % of the students and 20 % of the staff travel to the campus by car. This "performance" is the result of a dissuasive parking policy, combined with an excellent public transportation offer.[vi]

Founded in 1959 to allow for the expansion of the physics and biology departments, Hönggerberg now houses six department: Architecture and City Planning; Environmental and Civil Engineering; Physics; Chemistry and Applied Biosciences; Material Sciences; Biology. The first construction phase, launched in 1961, called for a dozen buildings (including a 15-floor tower), built around a roof garden above underground parking garages. In 1973, the Architecture and Civil Engineering departments also moved to Hönggerberg, to a 200-meter-long building with patios, located on the opposite side of the campus's main street. From 1999 to 2004, a large building complex housing the Chemistry, Life Sciences and Material Sciences departments, along with two laboratories,[vii] was constructed at the southeast entrance to the campus, for a total net floor space of 61,500 m2.

Hönggerberg has nearly 6,000 students and 3,500 professors, researchers and employees.[viii] More than 4,000 people work in research-related activity. Overall, the campus buildings represent a net floor space of 170,000 m2. Science City will expand to accommodate 12,000 people by 2015 (a 20 % increase in ten years), while adapting the campus to changing teaching methods, improving working conditions for users and opening up to its urban territory. The initial vision of Science City as a 'sustainable' university district focusing on science and the city was developed in the early 2000s by means of a participative process, using 'design labs.'

These workshops proposed some sixty programs, which were then consolidated into thirty projects, to strengthen ETH's position and breathe new life into this campus. Among them, the addition of a new tramway line in the canton's development plan for 2020, to link the regional train station of Oerlikon (a fast-growing sector) to Zurich's main station, with stops in Hönggerberg and Zurich West (an industrial sector that is home to many incubators and business parks). But under the pressure of neighborhood associations, which are strongly attached to preserving the popular and widely used forests and farmlands nearby, Science City had to accept a sine qua non: not expand beyond the current boundaries of the campus.

▪ Construction program and project implementation

The urban master plan for Science City was developed by the KCAP agency, after a competition launched in 2004 and made binding by the city of Zurich in 2006. It does not define the specific design of the new buildings, but rather stipulates a set of development guidelines that stress the functional aspects and spatial relationships between the structures (including pedestrian links, amount of sunshine received and shadows cast).

These elements were considered essential to the social and environmental quality of the campus. The various built and non-built areas of the campus are woven together so as to form a highly interconnected and dense fabric, encouraging the transformation of what is today above all a 'scientific hub' into what should constitute the second university urban quarter of Zurich in the future, after the downtown area.

The Science City program calls for the construction of 150,000 m2 of additional net floor space by 2015, representing a twofold increase in available surface area for the campus and an investment of around €165 million. Two buildings have already been constructed as part of this project, and others will soon follow:

- A sports center offering gym facilities to members of ETH and residents of neighboring towns, and also a place where physical education students can measure body movements. Open since early 2009, this building also has office space for firms conducting research into the disciplines studied on campus (like IBM) or banks that could finance spin-off companies.

- The Branco Weiss Information Science Laboratory (ISL), which will offer new collaborative tools. Opened in late 2008, it has a floor space of 16,500 m2 over six floors, with a capacity for 480 employees, 750 students and 500 work stations. The construction, 40 % of which was financed by private donations, cost €43 million. In addition to the offices laid out around a central atrium and six seminar rooms "suspended" around the atrium, it includes a multimedia project room fostering the design of collaborative projects by multidisciplinary teams from the various campus departments.[ix] The ISL is the first ETH building to have received the 'Minergie Eco Standard certification'[x]: the roof has 20 kW photovoltaic panels; air is circulated according to real-time demand by a ventilation system built into a false floor. Starting in 2013, it will be connected to the future campus's underground thermal control system.

- A life sciences institute occupying 21,500 m2 of net floor space; the basement houses a vivarium for 40,000 mice living in natural light, while the upper floors have offices and laboratories for 400 researchers from ETH, the Zurich University and biotech firms. The construction and equipment budget is €85 million. Scheduled for completion in 2012, this research building should have one of the smallest carbon footprints for buildings of its kind in all of Europe.

- Student residences, the first phase of which includes 400 rooms, were begun in 2009. According to David Mueller, director of the Science City project: *"Currently, we have got a lot of science here, but no city! And what is most missing at the moment is student housing. In two or three years, our new university dormitories will be a real milestone for Science City. We would rather construct the housings in several phases, because we want to improve campus access and life as we grow, by creating essential businesses and services: grocery stores, dry-cleaner's, child-care facilities and so on."*[xi]

- A learning and meeting center modeled after the Rolex Learning Center, recently opened at the EPF in Lausanne. For Gerhard Schmitt,[xii] *"The Science City Learning Center will be the largest of its 'public' projects. It should work like a motorway gas station opened 24/7, like a 'science tankstelle'. From this place, anybody should be able to look 'visually' at any piece of research done on this campus or on the other Zurich campuses through virtual means. At the same time, it should be a learning center for the students, so the libraries that are distributed all over the campus should be networked to a bookless library. In addition, scientific congresses/conferences should take place in that center but not in a classical setting."*

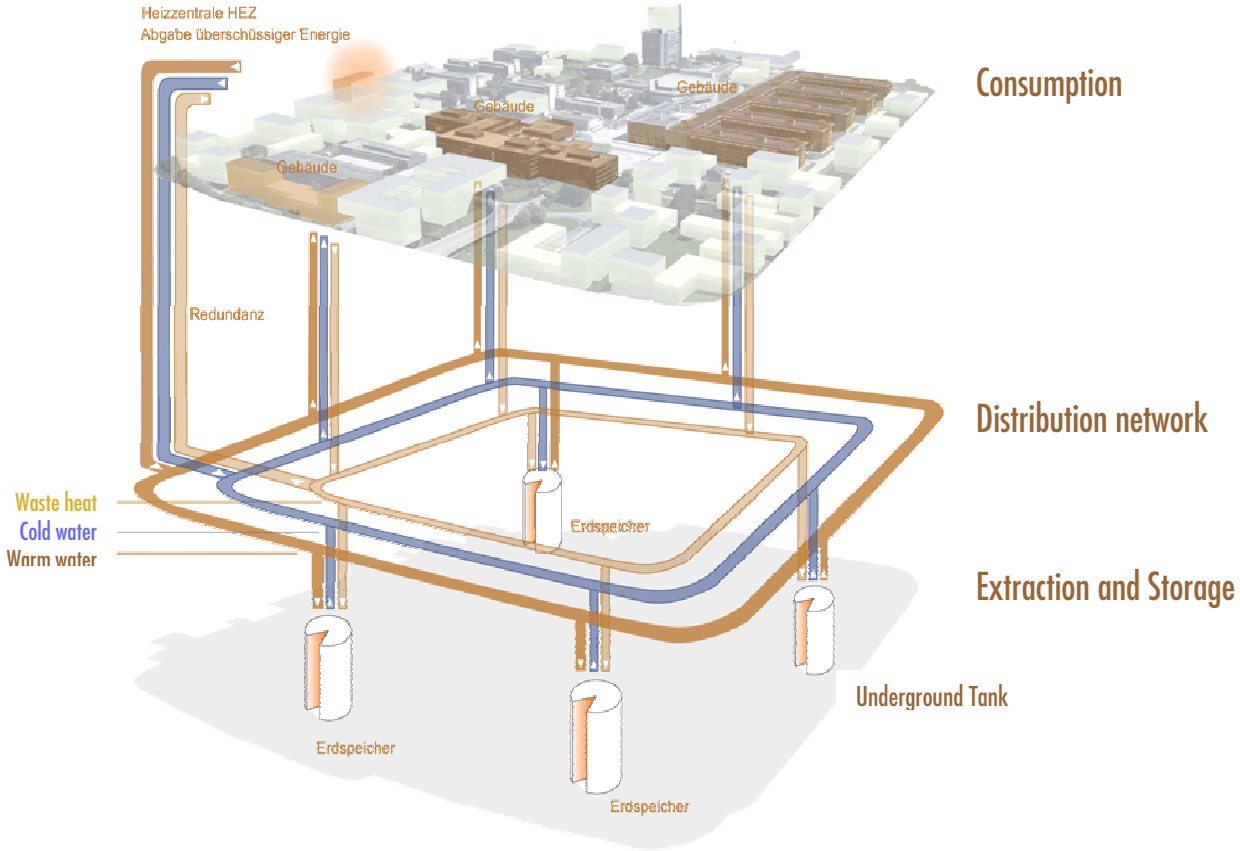

Information Science Lab : © L.Perrin/IAU


Rolex Learning Center : © EPFL/Sanaa

Future heat storage and distribution system

After considering several alternatives to reduce the energy consumption on the Hönggerberg campus (replacement of all the hot water tanks, connection to the urban heating system, construction of a wood-fired power plant, deep geothermic drilling), to comply with its commitment to cut its CO^2 emissions in half by 2020, ETH decided to take advantage of its underground hot-water distribution system to construct a dynamic underground heat storage system using heat exchangers in the hearth. According to Gerhard Schmitt: *"in the near future we will heat the whole campus thanks to the energy dissipated by the research instruments (including computer clusters). For this we shouldn't look at individual buildings' energy needs, but consider the whole campus as a living organism with some of its parts producing heat and some consuming it. Fortunately for us, the Hönggerberg campus was built during cold war times and it's surrounded by underground pipes that we can just reuse. Up to now, we had basically to destroy energy in the form of cooling down the scientific instruments and throwing out the heat, whereas now we'll be able to exchange it with other buildings. This is already the case for instance of the Information Science Laboratory. Those buildings that have low internal loads are like the 'cooling ribs' of the heat producing ones."*

Strengths
A holistic planning process, with a wide overlap of various scientific, architectural and urban elements involved in the development of a university campus.
A pragmatic and realistic project in terms of scheduling and implementation, integrating the required constraints of financial, technical and political feasibility.
An exemplary campus in terms of energy resource management, which will recycle and redistribute excess heat produced by the scientific instruments.
Weaknesses
A number of Zurich stakeholders external to ETH don't consider this approach practical enough, although they view it as interesting on an intellectual and marketing basis.
The project still has not produced the desired effects in terms of urbanism: the Learning Center is still in the planning phase, while the EPFL already completed its own. The 1,000 housing units scheduled for the long term will certainly not create a critical mass sufficient to breathe life into the campus.
The impossibility of hosting and developing start-ups in the immediate vicinity of the campus, so that they could participate closely in the campus life.



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An example of a network cluster: Life Science Zurich

Zurich has one of the most competitive life science clusters in Europe: Life Science Zurich. Created from the academic collaboration between ETH and the University of Zurich in 2002, this initiative was then expanded to technology transfer institutes and companies. Under the umbrella brand "Life Science Zurich," the cluster now includes actors and local and national networks working in the life sciences. Boosted by the proximity of multinational pharmaceutical firms like Roche and Novartis in Basel, and the strength of its financial marketplace, the academic excellence of Zurich in the biomedical sciences is a driving force for innovation in the life sciences.

The Life Science cluster is unique in its multi-scalar form. It has several centers in the city of Zurich, along with privileged links with nearby Baden-Württemberg and Basel, and international networks. Its primary actors are universities and the many innovative spin-offs and start-ups located in the immediate vicinity and dedicated spaces (Technopark and Biotech Center in Zurich West, Grow in Wädenswil). The combined actions of universities and private firms create favorable conditions for these start-ups: space at affordable rent in the university laboratories during the first years, or in the bioparks and business incubators; solid support from investors in the health sector.

- **The "Training – research – firms" triptych and their co-operation**

Nearly all the major multinational firms located historically in Basel, notably the pharmaceutical ones, work with ETH, the University of Zurich (one of the five leading European universities in the biomedical sciences, thanks to its teaching hospital) and the small- and medium-size technology firms. The synergies between the two academic institutions have gradually grown, fostered by the physical proximity of their downtown campuses; this has resulted in joint research projects and mutual training programs.

But other Zurich institutions also contribute training and research efforts to this emerging cluster: the teaching hospital of Zurich (Switzerland's primary hospital); the Life Science Zurich Graduate School (LSZGS), with 900 doctoral candidates; and the Zurich University of Applied Sciences in Wädenswil. The Life Science Zurich cluster includes many "scientific competence centers" that ETH and Zurich University have set up over the years: Systems Biology (SystemsX.ch); Systems Physiology and Metabolic Diseases (CC-SPMD); Neuroscience Center Zurich (ZNZ); Cancer Network Zurich (CNZ); NCCR Structural Biology; Plant Science Center (PSC); Functional Genomics Center Zurich (FGCZ); BEST BioEngineering Cluster (BEC); Center for Imaging Science and Technology (CIMST).

Zurich is also the headquarters for a number of international biotech firms (including Amgen, Arena, Baxter, biogen idec, Cilag and Ecolab) and many start-ups (such as Amvac, Cytos, Esbatech, Glycart, Glyco Vaxyn, etc.)

Biology is now allied with other research sectors that have worked closely together for many years, including the engineering sciences, mechanical construction, chemistry and pharmacy. For companies, the Zurich university campuses offer a twofold benefit: a quest for excellence conducted by university laboratories and the quality of multidisciplinary teaching (biology and computer sciences, for example), which creates an innovative way of meeting the interdisciplinary challenges of the future.

ETH Transfer has an impressive portfolio of 1,200 research contracts, more than 400 patents pending and more than 50 spin-offs.[xiii] More than one-quarter of them work in pharmaceutical products and biotechnology, chemical compounds and processes, medical equipment, diagnostics, sensors and analyses.

Well-organized incubators like Biotech Center Zurich and Biotop Life Science offer a complete line of services and infrastructure for life science start-ups that are already established or just setting up. A 23,000 sq. m expansion project is currently underway to meet the increasing demand. The Grow incubator, located southeast of Zurich, also houses biotech firms right next to the University of Applied Sciences.

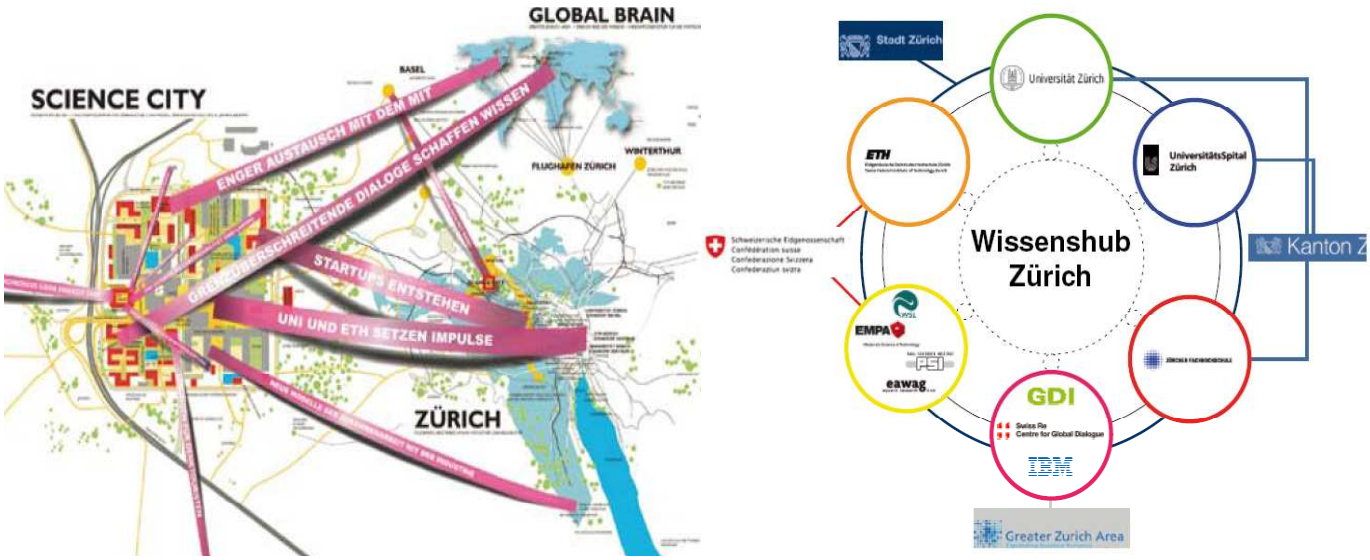
> Science City in the Zurich 'Wissenshub'

The Technopark Zurich, located in the former industrial district of Zurich West, has medium- and long-term rentals of laboratories and office space for high-tech firms. An entire wing is set aside for start-ups initiated at ETH. The academic actors play an unquestionable role in the success of the Life Science Zurich cluster. The many spin-offs attest to the vibrant energy of the universities. The lack of very large firms in the cluster, however, may raise problems in the future (note that the major pharmaceutical firms are located in Basel). This also raises the question of a cluster's critical mass, which to exist on the international scene must be associated with other Swiss clusters: is the coordination of a network Life Science cluster on the Swiss Confederation level conceivable, given the community and cantonal economic prerogatives and, if so, would it be truly effective?

Strengths
Life Science Zurich is a dynamic cluster (in terms of the number of start-ups created) in the process of consolidating and it has a real international appeal.
The real-estate offer in Zurich West lets start-ups develop in situ, allowing them a necessary flexibility. A new extension of the Biotech Center confirms the appeal of the site for firms in the life sciences sector.
The Zurich financial market offers easy access to all types of capital required for the growth of high-tech firms.
Swiss history and its culture are favorable to the collaborative approach of multi-scalar networks.
Weaknesses
The major businesses in the sector (pharmacy and chemistry) are historically located in Basel, so the cluster could have difficulty in the long term, single-handedly reaching the critical mass necessary for international visibility.
The Schlieren site in Zurich West is a district purely devoted to industrial activities, and lacks the urban ambiance appreciated by techno-entrepreneurs.
The typically Swiss "cantonalism" interferes with a smooth coordination of policies and development projects, which must be conducted on a macro scale.

Zurich *Wissenshub*

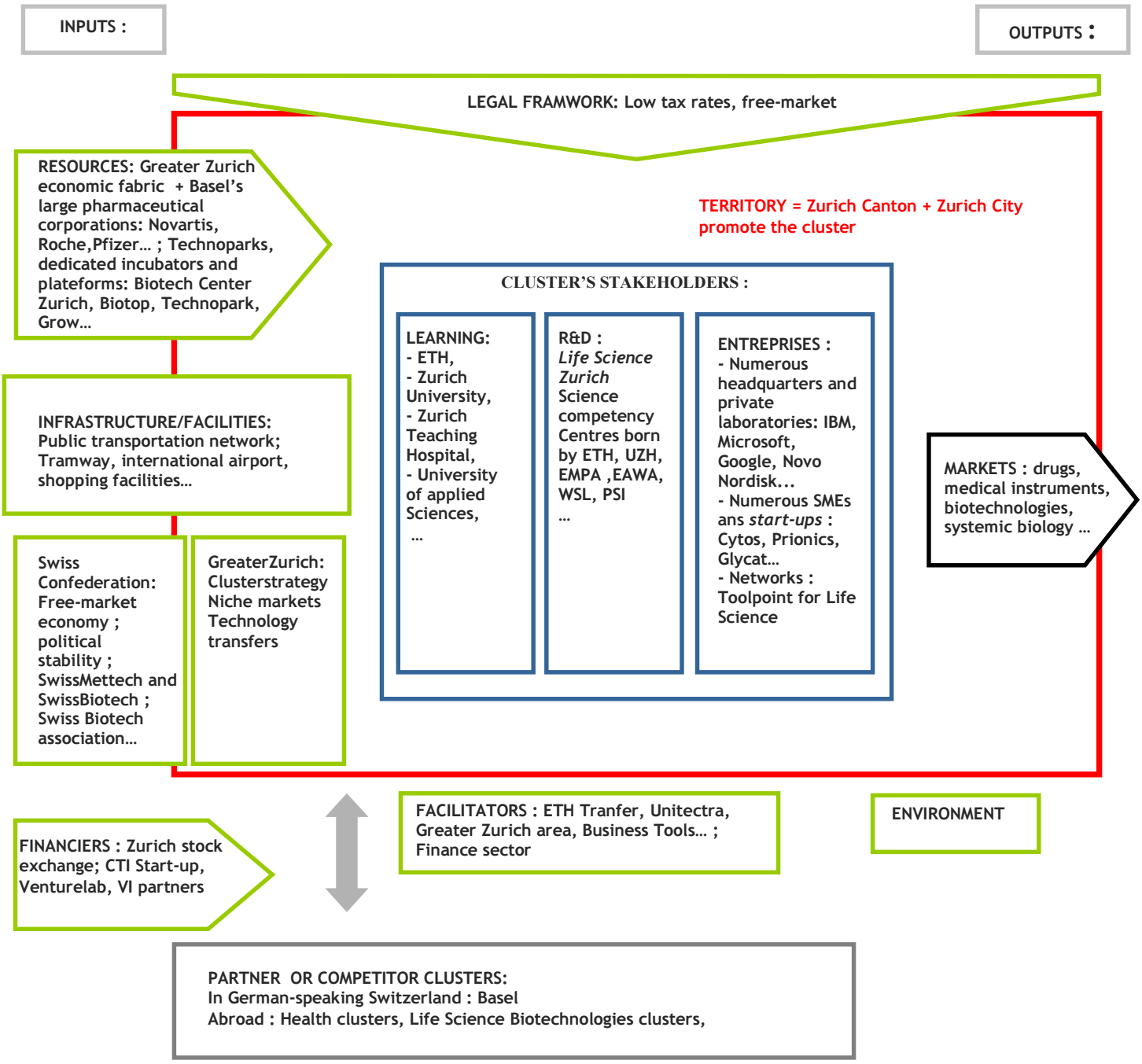
The Hönggerberg Science City project is not, strictly speaking, adjacent to an economic cluster. Yet it is part of a strategy for networking actors in research and innovation in the Zurich metropolitan area, the *Wissenshub*. Indeed, business parks cannot be created in the immediate proximity of the Hönggerberg Science City, but the size of Zurich and the good public transportation system means that high-tech business parks and firms can be easily linked to ETH. The *Wissenhub* must therefore facilitate the interconnectedness of the Zurich research and development ecosystem. While at first sight, it focuses strongly on science and technology, this transversal hub could be a driving force for a better integration with the economic forces, notably the small- and medium-sized firms (technological transfer, spin-offs, start-ups, international appeal: foreign talent, R&D centers of multinational firms, etc.)



Multiscalar representation of ETH Science City position within the Zurich *Wissenshub* © ETH Zurich

Life Science Zurich cluster mapping:

The analysis of the Zurich cluster in life sciences aims to examine its overall "ecosystem". Beyond the triptych of founding firms, R&D structures and educational institutions, an analysis of the elements provided from a territorial standpoint is essential to understanding the logic and benefits of a cluster.



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[i]-30,000 euros per resident in 2008.
[ii]-8.5 billion euros were invested in R&D in 2004. Switzerland holds the second place after Sweden, with a per capita expenditure of 960 euros (source OFS).
[iii]-Their budgets represent 4.5 % of the $532 billion slated for R&D investments in the world!
[iv]-Life sciences firms have collected more investments in Switzerland than anywhere else in the world, thanks to the support of the Swiss financial market for the health sector. Approximately one-third of the total capitalization listed on the Swiss Exchange (SWX) can be attributed to firms in the life sciences sector.
[v]-20th in 2009, according to the Times Higher Education Supplement ("World University Ranking") and 23rd in 2009 according to the Jiao Tong university of Shanghai. Albert Einstein is one of the 21 Nobel Prizewinners to have attended ETH.
[vi]-Two city bus lines and mini-bus shuttles between the various ETH campuses.
[vii]-The FIRST lab and the Center for Imaging Science and Technology (CIMST).
[viii]-Representing 43 % of the ETH staff.
[ix]-Equipped with a triple tactile LCS screen, two interactive tables and high-resolution video projectors.
[x]-In Switzerland, equivalent to the BBC standard.
[xi]-In the long term, the total housing capacity on the campus will reach 1,000 units. Note that the project originally called for adding three or four floors to the Hönggerberg tower to create a hotel, but ETH did not find a hotel company.
[xii]-Former Vice-President responsible for planning and logistics, and creator of the Science City project.
[xiii]-Including a record number of spin-offs founded in 2007.