ETH zürich

Competence Center for
ETH Spatial Politics

Envisioning a **Future** for ETH Real Estate

Department for the Future
Competence Center for ETH Spatial Politics

Competence Center for
ETH Zurich Spatial Politics

Edited by Department for the Future
Competence Centre for ETH Zurich Spatial Politics, ETH-SP
ONA G23, Neunbrunnenstrasse 50
8050 Zurich, Switzerland

Contributors Victoria Balmer, Jonas Baltensperger, Linus Maurer, Florin Meier, Tim Moosbrugger, Louis Prongué, Eugen Wiskemann

Front Page Fig. [0.1]: Swiss Federal Observatory at ETH Zurich, 1911

Content

Foreword 4

1. Reaching 2050 6

2. Future Strategies for ETH's Building Stock 36

3. Future for Rooms | Rooms for Future 56

4. Past and current Visions for Campus Hönggerberg 94

Conclusion and Reflections 118

Sources 121

Foreword

The buildings and infrastructures of ETH are a crucial part in reaching the institution‘s target of excellence. The confrontation with new challenges and urges of our time impose the necessity to rethink current planning strategies and envision new solutions. This report shall provide an opportunity to reflect, question and rethink, thus offering new narratives for the future.

ETH Zurich is one of the globally leading universities for technical and natural sciences. In the institution's self-imposed goal of achieving excellence in teaching, pioneering research and the transfer of scientific knowledge into practice, its spatial infrastructure plays a vital role. Since the school's foundation in 1855, the real estate portfolio has continuously been expanded and transformed, following the guiding principle of constant institutional growth. As in these past 168 years of history, the meaning of a well-planned, strategically oriented and sustainable real estate management will remain of high importance in the future of ETH as a national institution and global player for scientific research and education. The investigation of processes, interrelations, histories and imaginaries, related to ETH's real estate development, is thus of eminent meaning for the competence center's Department for the Future and will allow to create future-proof approaches to ETH Zurich's development.

This report is compiled of four chapters, offering insights into the past, current and future real estate management of ETH on four different levels and scales. From allocating ETH Zurich in Switzerland's infrastructural networks, to interrogating the necessity for newly constructed buildings through the lens of individual rooms, a diversified insight is provided.

The chapter **Reaching 2050** explores infrastructural energy systems and strategies on scales from the whole nation to the single laboratory, as well as ETH's allocation within them. The investigation offers insights into the current condition and future vision of the institution's energy systems and takes a critical stance towards the ubiquitous dogma of technology-based solutions. A variety of strategies, from energy labels to behavioral change, are interrogated in search of more sufficient future solutions.

In **Future Strategies for ETH's Building Stock** the procedural and strategic approaches to developing ETH's current building stock are investigated. The processes of space-making, applied by ETH real estate management, are explored and reflected by a comparative analysis of different development strategies at hand. An investigative comparison of energy balances, environmental and ecological impacts, as well as the uncertainty of future scenarios stands at the basis of the discussion.

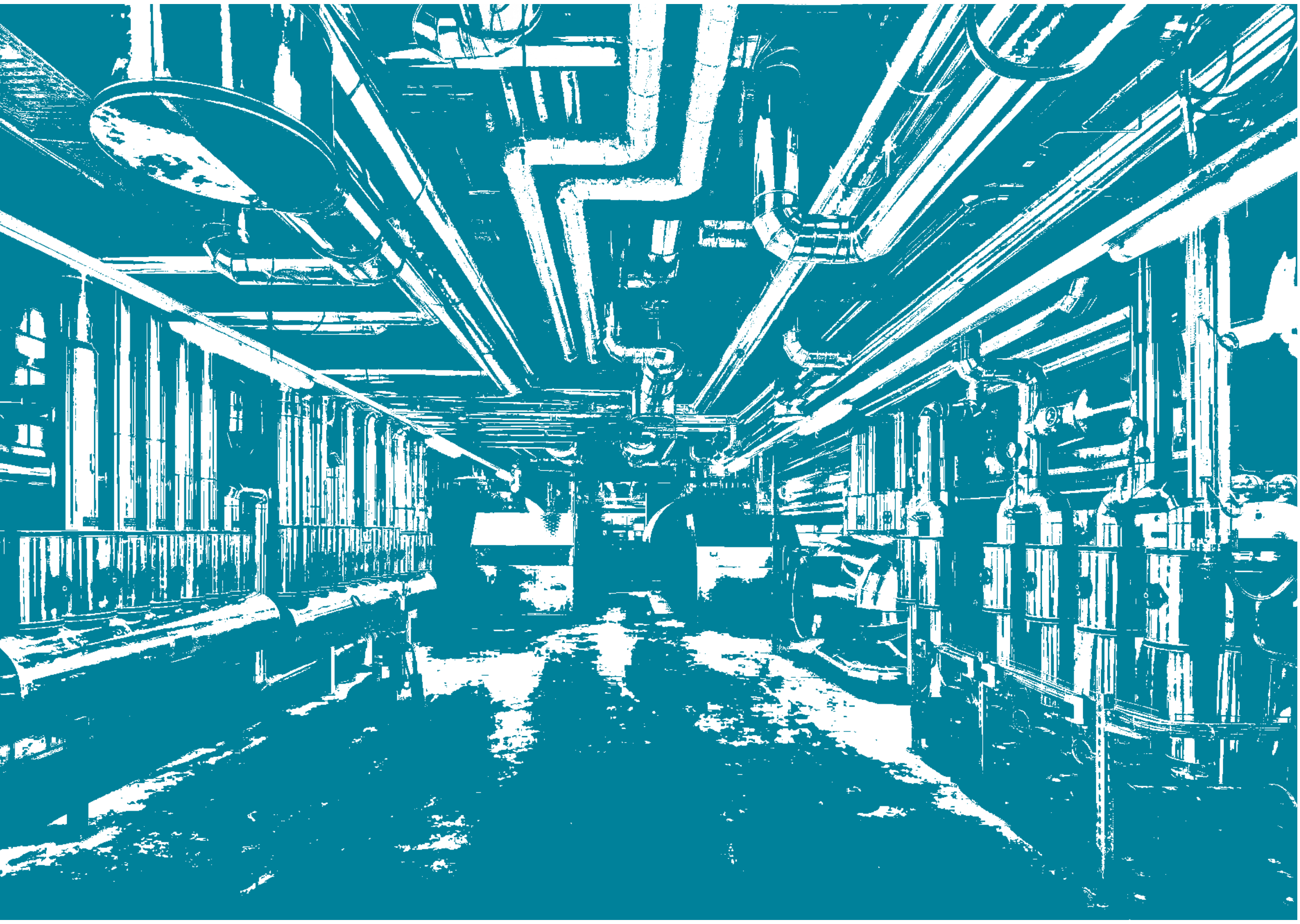
Future for Rooms | Rooms for Future puts the role of the single room as the protagonist of real estate planning and the mediator between people and excellent infrastructures in the spotlight. After a critical approach to the ubiquitous notion of institutional growth, the current organization of ETH's use of space and its inefficiency are investigated, in order to identify potentials for organizational densification. In a last step, a glance is cast at the promises of new imaginations of future work environments.

In **Past and current Visions for Campus Hönggerberg** the idea of the masterplan as a basic tool of long-term planning is examined critically. An investigative comparison of a selection of masterplans from the 20th and 21st century presents insights into the future scenarios, conveyed by visionary masterplanning. Not only does the chapter thus give insights into the past conceptions of ETH's thinkers, but it also allows to critically reflect on the general power and limits of masterplanning.

This diversified compilation of perspectives onto ETH's real estate planning and its possible futures shall create the opportunity to question and rethink current dogmas, strategies and visions. By giving attention to new challenges and urges of our time, a moment of broad reflection and reconfiguration is the target of this report by the Department for the Future.

Reaching 2050: Energy from Different Perspectives

ETH depends on a great amount of energy. Whether electricity, heating or cooling energy, the institution is through its energy consumption dependent on the surrounding nature, the city of Zurich or Switzerland. This Research Angle of the report aims to explore various concepts and strategies, as well as to shed light on interconnections, dependencies and interests.



Inroduction

This research angle is divided into 3 chapters, which in turn are subdivided into various subtopics. This introduction gives a brief insight into each of these chapters and explains the method used to draw a conclusion.

Scales
In order to understand ETH's energy and sustainability strategies, they cannot be isolated from the context of Switzerland and especially not from the context Zurich. The 'Scales' chapter starts with energy production and policy in Switzerland and continues with the one of the city of Zurich and ends with energy production and usage at ETH. The ETH institution is on the one hand made up of the two well-known campuses in Zurich, but on the other hand also of various external locations spread throughout Switzerland. To get to the bottom of ETH's position on this complex issue in detail, the scale of the buildings and laboratories is also addressed at the end of this chapter.

Systems
The chapter 'Systems' examines the energy production processes used at ETH. After a brief retrospective on the Walche heat pump, an overview is given of the systems currently used on the two campus, along with an outlook on the lake water use for cooling the Campus Zentrum from 2035.

Strategies
ETH has various strategies to pursue on different levels with the aim of improving energy consumption at the institution. To open the chapter, the concept of the 2000-watt society which was developed at ETH is explained, illuminated from various angles and reflected on, especially in its relation to sustainability labels. This is followed by a more detailed discussion of sustainability labels within the construction industry, focussing on Minergie. Finally, the topic 'Designing Behaviour Change' offers an outlook on how sustainable behaviour can be promoted at universities through targeted measures.

Method
Architecture's role in these complex interdependencies can only be recognised with a general understanding of energy consumption, energy production and energy policy. In the respective chapters, a bridge is drawn from the general explanations to the effects on and dependencies with the built environment. The aim of this research angle is to reflect on the status quo and provide action recommendations for the future.

Energy on different scales

Switzerland

Relationship of Dependence
Switzerland currently consumes an average of around 810,000 TJ of energy per year and around 70% of this is supplied from abroad. In an international comparison, Swiss consumption is above average and more than 1.5 times the global average. [1.1] Most energy is consumed in the form of fossil fuels. They account for 43% of total energy consumption, followed by electricity with a share of 26% and gas with 15%. [1.2]

> In an international comparison, Switzerland consumes an above-average amount of energy.

A quarter of the country's oil demand is processed in the Swiss refinery in Cressier. The crude oil comes from Nigeria, the USA and Libya. The remainder is imported from the EU in the form of finished products.

Around 60% of the natural gas consumed in Switzerland is produced in EU countries and Norway. 35% comes from Russia and the remaining 5% from various other regions. [1.2]

Electricity produced vs Electricity supplied
In 2021, around 60% of the electricity produced in Switzerland came from large hydropower plants, 30% from nuclear power plants, 8% from new renewable energies[i] and 2% from fossil fuels. However, the supply mix that reaches the sockets does not come exclusively from Swiss production. There is extensive trade, especially with EU countries. While Switzerland exports surpluses in summer, it has to import roughly the same amount of electricity in winter. About 68% of the supply mix[ii] comes from large-scale hydropower, 19% from nuclear energy, 11% from new renewable energies and just over 2% from waste and fossil fuels.

Growth Is Everything
Switzerland shows a tendency to grow steadily in all sectors. Whether it is the economy that is supposed to grow, the transport industry that is expanding or the efficiency of machines and buildings that is being increased, most publications state that we need to grow in order to be well. Yet we should question whether the increase in luxury is in fact sustainably beneficial for our society. [1.2]

Visions for the Future
Switzerland has set itself the goal of ensuring that it can rely as much as possible on its own domestic supply and reduce its dependency on fossil fuels and thus on foreign countries. At the same time, CO2 emissions are to be reduced and the climate targets of the Paris Agreement[iii] are to be achieved. Three overarching measures that will be taken to achieve this are: increasing the energy efficiency of buildings, machinery and transport, promoting renewable energies and refraining from using nuclear power. However, predictions suggest that the energy reference area[iv] will continue to increase until 2050, i.e. the operational energy demand in the building sector will continue to rise. The proposed solutions to this specific problem include the reduction of fossil fuels and nuclear power, the conversion of gas plants to biogas and the promotion of district heating. Likewise, great importance is attached to making the built environment less energy-intensive through energetic refurbishment and technical developments. [1.3]

Switzerland therefore relies heavily on efficiency and consistency measures. Sufficiency, the third element of sustainability theory[v], is not mentioned as part of the strategy. However, it could make a crucial difference to educate Swiss citizens by means of national sufficiency campaigns in order to promote more sustainable behaviour patterns and to reconsider certain comfort standards

i) solar, wind, biomass and small hydropower

ii) Since 2005, companies are legally obliged to disclose the origin and composition of the electricity they supply to guarantee transparency for end customers and not primarily to serve the expansion of renewable energies.

iii) Paris Agreement targets are aimed at limiting global warming to well below 2 °C compared to pre-industrial times until. To limit global warming to 1.5°C, greenhouse gas emissions must peak before 2025 at the latest and decline 43% by 2030. Net-Zero should be reached by 2050.

iv) The sum of all above-ground and below-ground floor areas that lie within the building envelope and for which heating or air conditioning is required.

v) Efficiency: producing more with fewer resources,

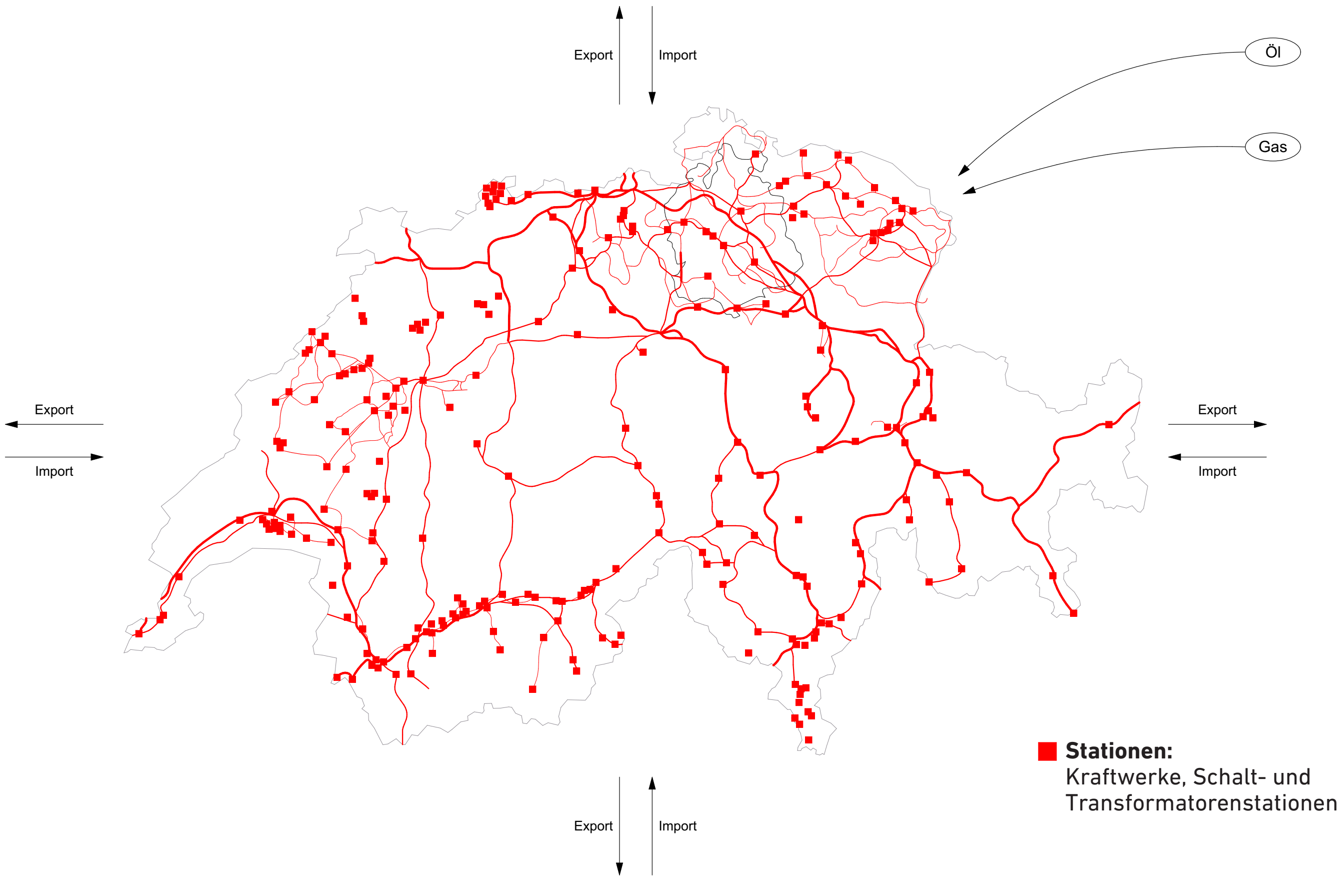


Fig. [1.1] Schematic representation of the Swiss electricity grid and dependency relations with other countries.

Zürich

> Zürich's prognosis is not compatible with federal targets.

Producing Electrical Power

The City of Zurich and its affiliated companies operate various technical facilities from which the city's users and residents can benefit. These include water treatment plants, that use water from springs on the hills, the Limmat and the lake and distribute it to the individual buildings, or municipal electricity plants, such as the EWZ at Letten. [1.4]

Waste Is Keeping Us Warm

For heating, there are waste incineration plants that recycle or incinerate the city's waste[vi]. Additionally there are plants that recover heat from waste water [vii] in Altstetten, as well as smaller heating centres with wood heating systems. [1.4]

Targets Are Not Matching

What is alarming about the heat supply is that the reports that treat the city of Zurich level still expect a 42% fossil fuel share in 2050 and are therefore not compatible with the federal government's targets. [1.5]

Consistency: change in production, only using resources and technologies that don't impair ecosytsems, Sufficiency: change in human life-styles to save resources

vi) see chapter Systems, District Heating

vii) wastewater treatment plant = Abwasserreinigungsanlage (ARA)

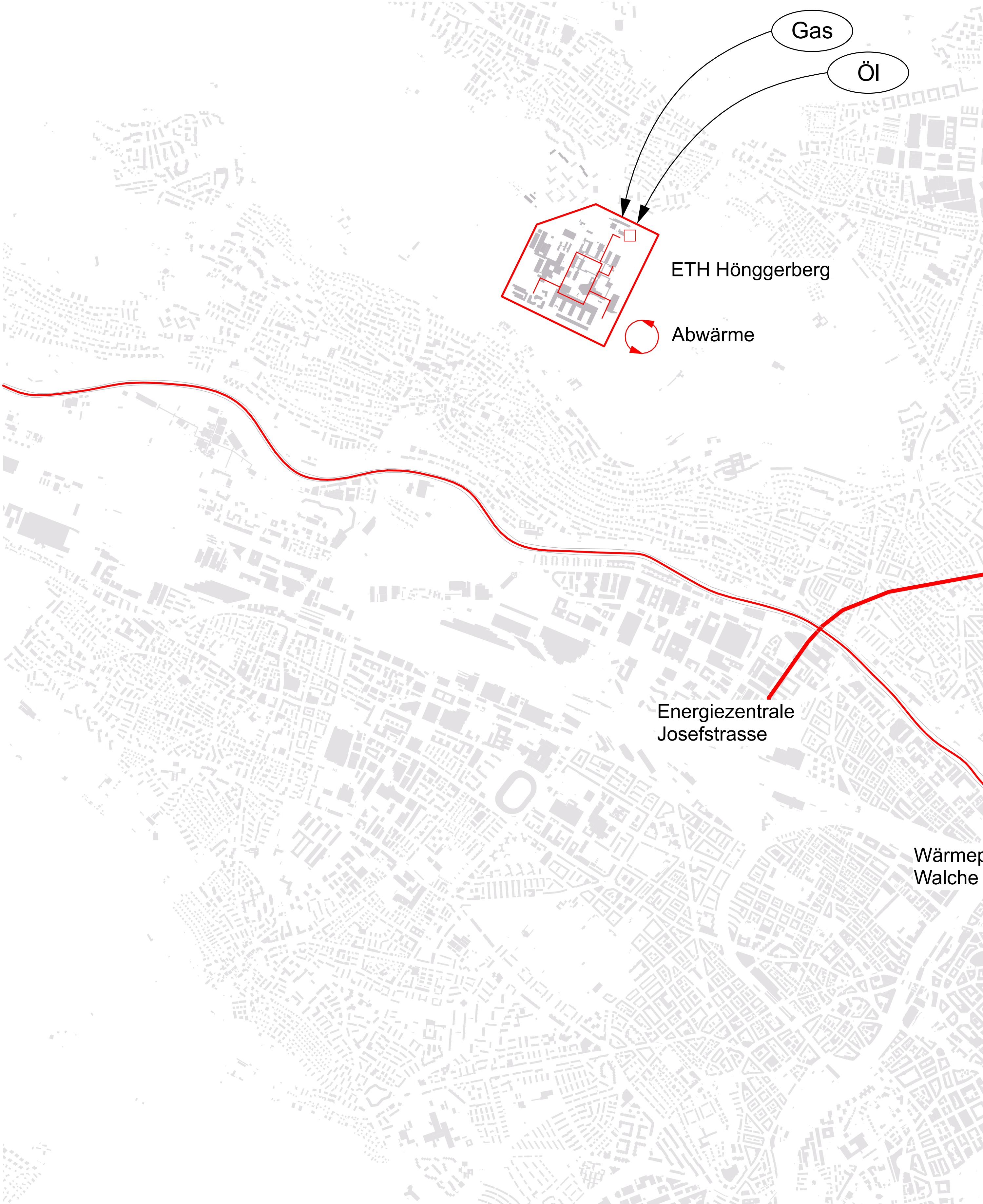
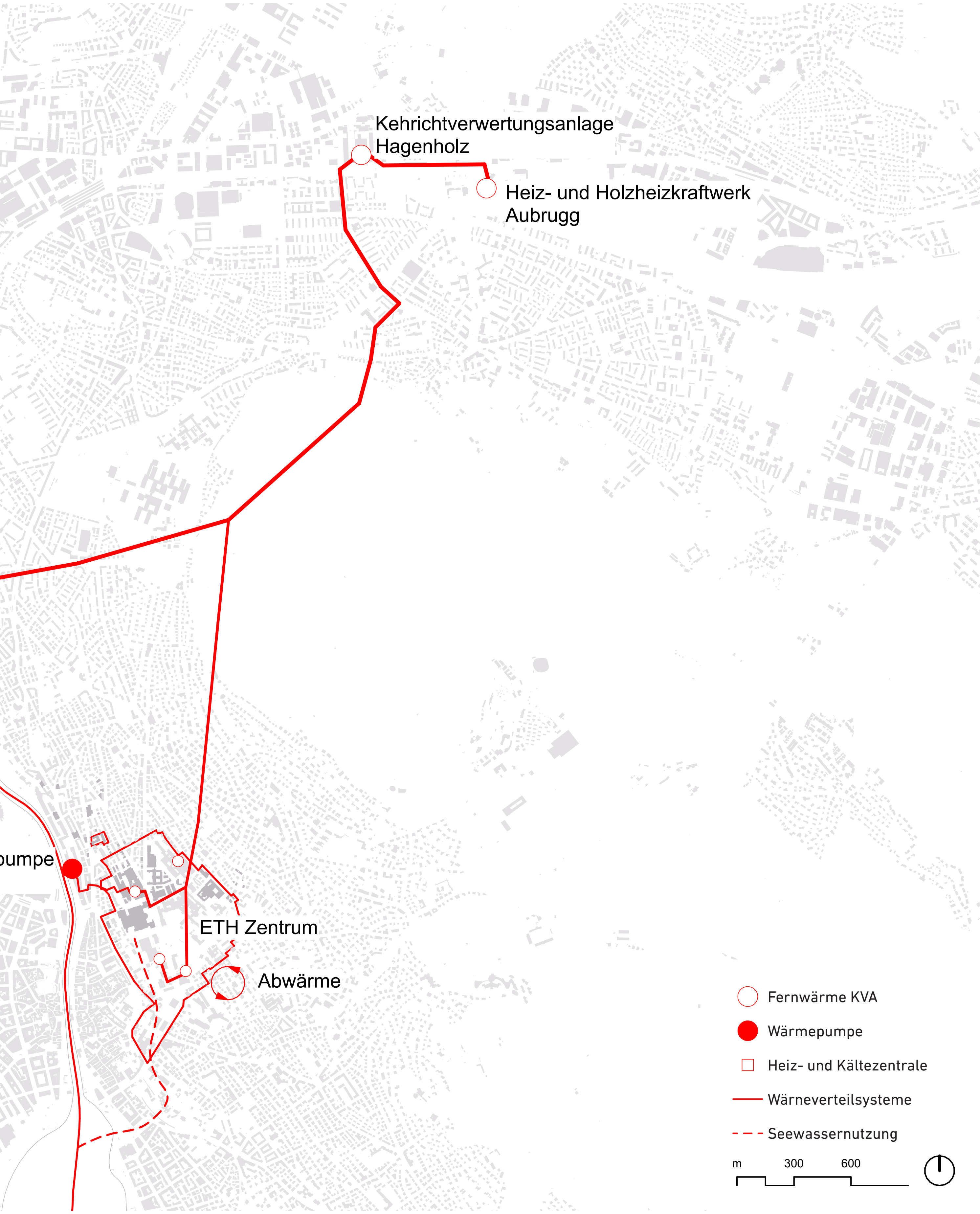


Fig. [1.2] Map of Zurich's Main Heat Supply Networks in Connection to the two ETH Campus


Kehrichtverwertungsanlage
Hagenholz
Heiz- und Holzheizkraftwerk
Aubrugg
pumpe
ETH Zentrum
Abwärme
Fernwärme KVA
Wärmepumpe
Heiz- und Kältezentrale
Wärneverteilsysteme
Seewassernutzung
m 300 600

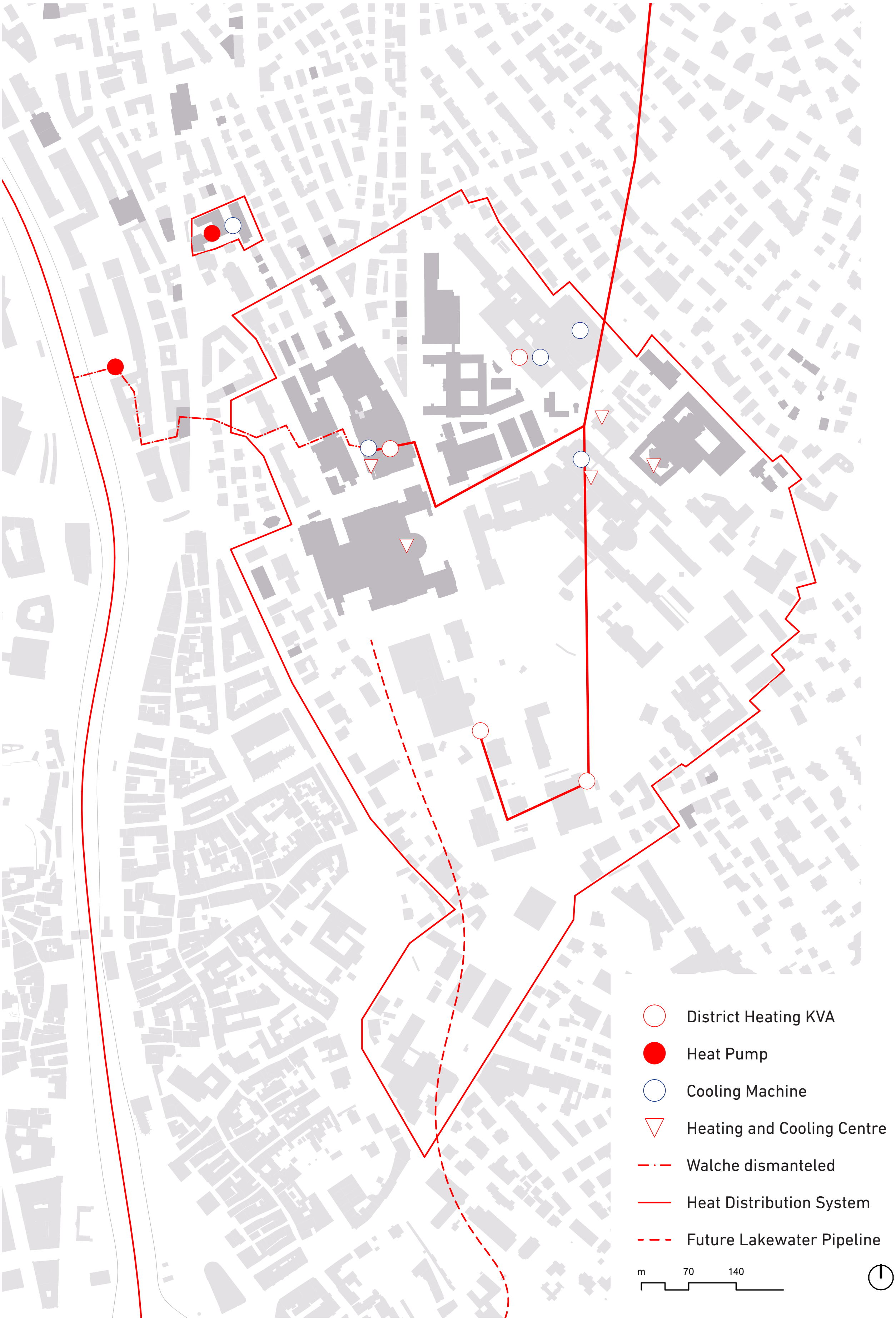


Fig. [1.3] Map of Heat Supply Networks in the Hochschulquartier

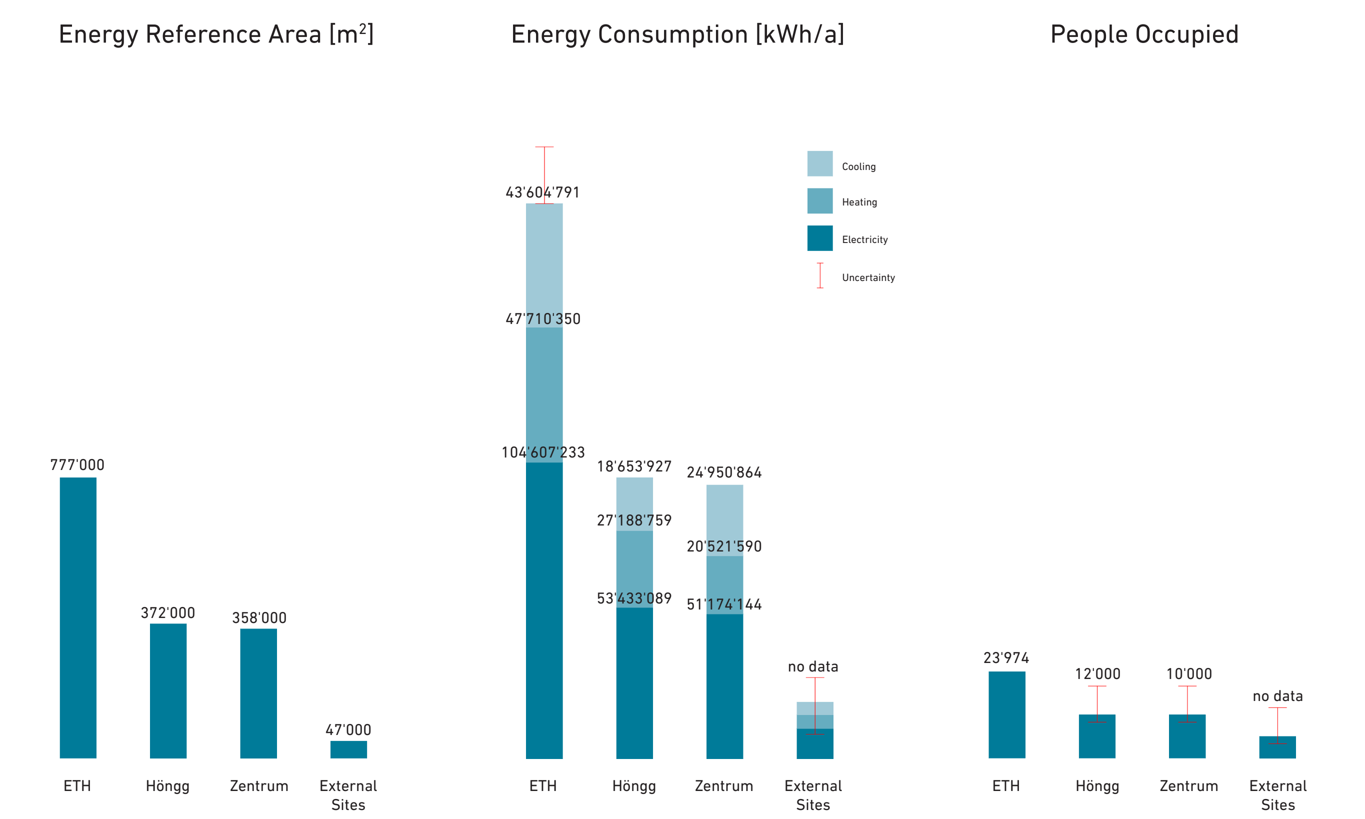


Fig. [1.4] The energy reference area, Energy Consumption and People that are occupied at Campus Hönggerberg, Campus Zentrum and the external sites in relation.

ETH

The ETH building stock, with an energy reference area of around 777,000 m2 , can essentially be divided into 3 categories. There is the campus on the Hönggerberg, which accounts for 372,000 m2 of the energy reference area, the Campus Zentrum with an energy reference area of 358,000 m2 and external sites, which are made up of various smaller buildings and have a total energy reference area of 47,000 m2. [1.6]

Zentrum
ETH Zurich has a large number of older buildings in the centre, which lose more heat through the building envelope due to their construction standards. Some of these are listed buildings, which means that renovations can be challenging.

In the past, the heat pump under Walcheplatz[i] covered a large part of the heating requirements of the Hochschulgebiet. However, this became too economically unviable over the years and was therefore dismantled.

Today, the buildings are mainly heated through district heating[ii] with a direct connection to the Hagenholz waste incineration plant in Zurich Oerlikon. In addition, waste heat is being recovered and fed into an internal system.

For cooling, a system is currently used that has 3 cooling centres[iii] located within the Hochschulquartier. From 2035, a connection to Lake Zurich[iv] is planned as part of the expansion of Stadelhofen railway station, so that the lake water can be used for cooling. [1.7]

i) see Chapter Systems, Walche Heat Pump

ii) see Chapter Systems, District Heating

iii) see Chaper Systems, Mechanical Cooling

iv) see Chapter Systems, Lake Water Use

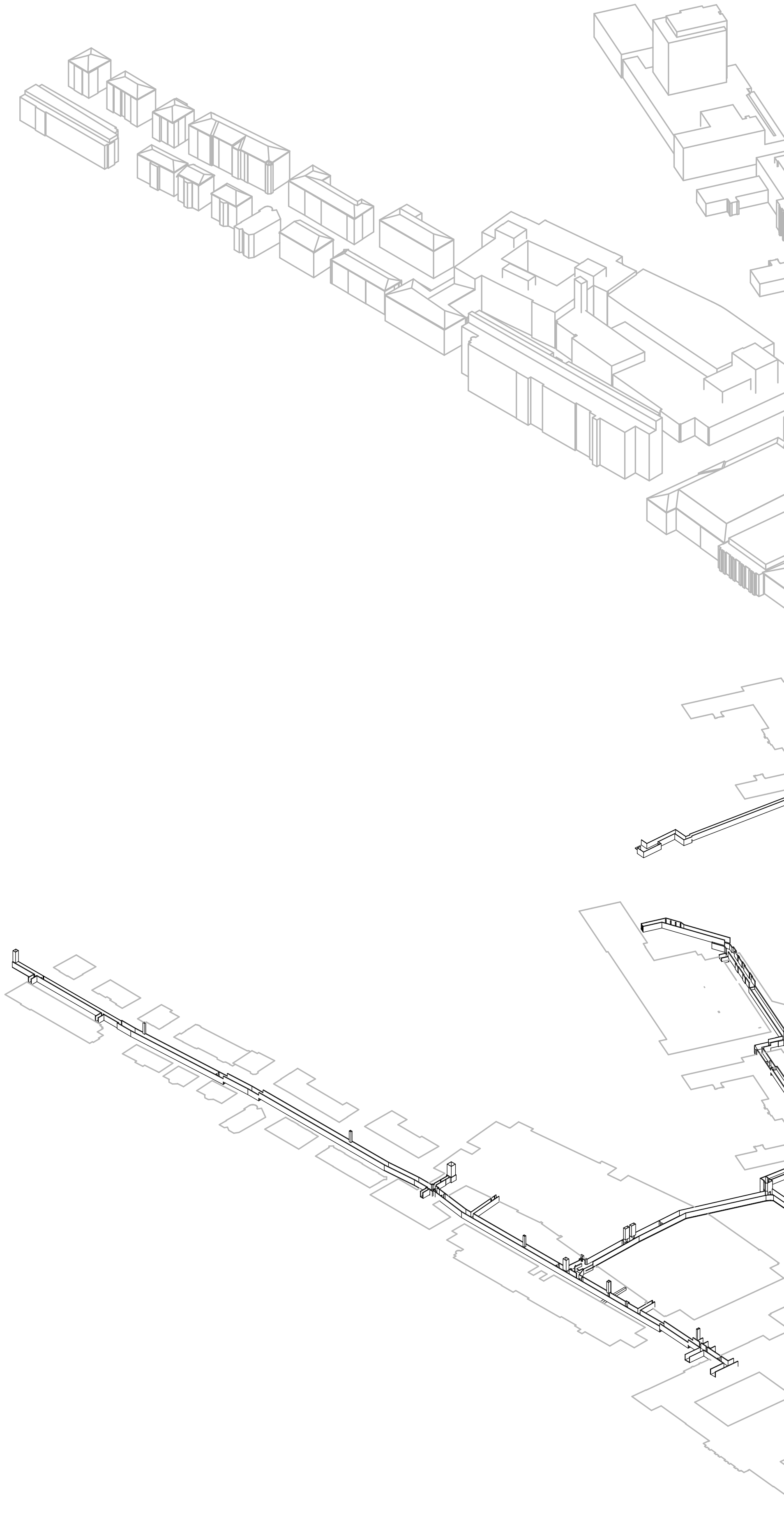
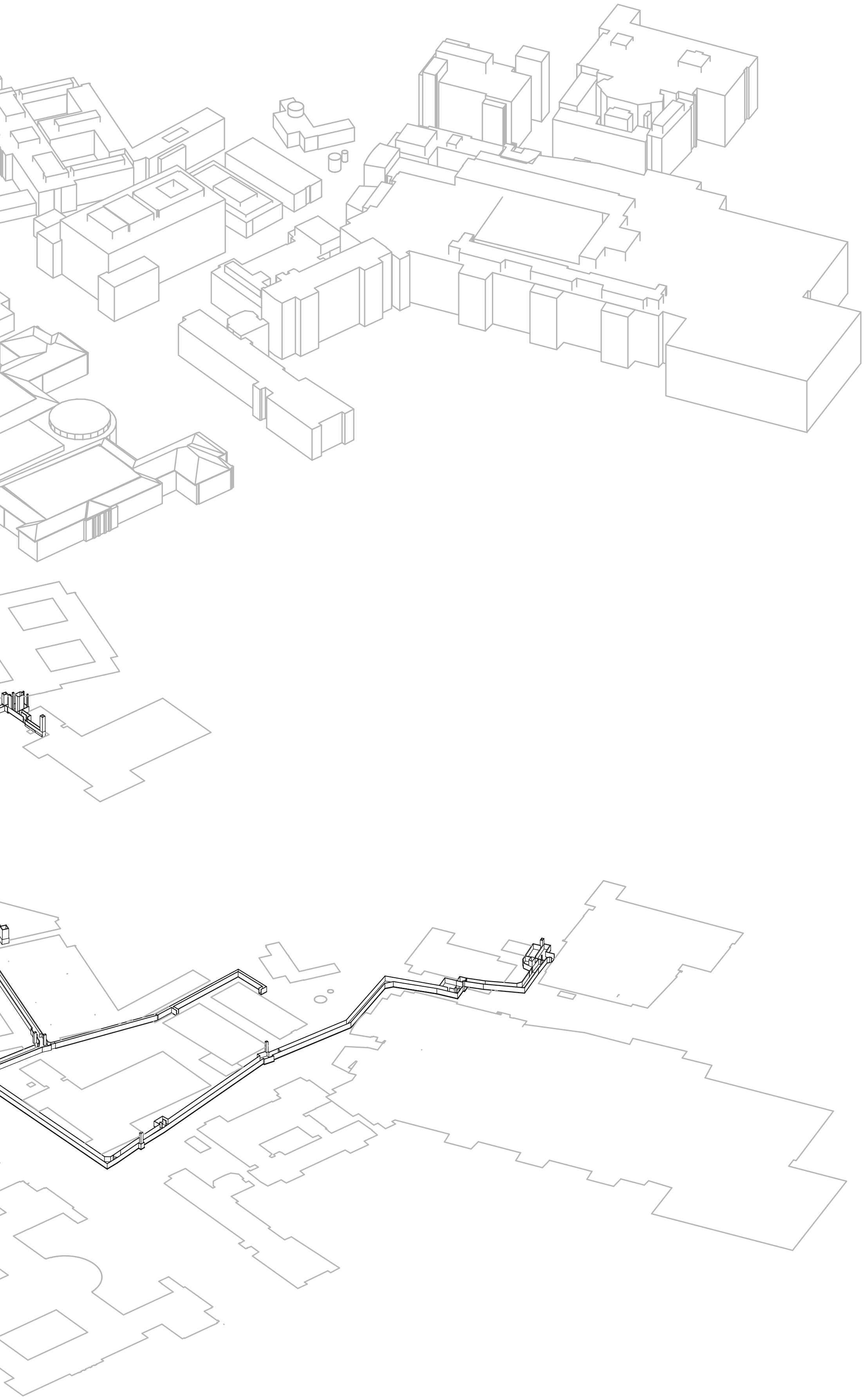


Fig. [1.5] Explosive Axonometrie of the EWZ (Energiekanäle Zentrum)



External Sites

At the external sites, the energy supply is somewhat more difficult to control and is not always in the hands of ETH. The buildings on the campus of the University of Basel, for example, are dependent on their systems. In other buildings, both inside and outside Zurich, ETH has only rented space and has no direct control over the energy supply. For example, ETH is accommodated in units in the Andreasturm in Oerlikon, where it only moved in as a tenant in 2023 after the building was finished in 2018.

Other examples include the Schwerzenbach site, which is the largest site still powered by gas. The site Eschikon-Lindau has a wood chip heating system and at the one in Rüschlikon the ETH is connected to the IBM energy system. Certain small properties are still run on fossil fuels. As it is very difficult to replace these smaller fossil energy systems all at once, the ETH demands that any system that is replaced from now on must be replaced with one based on renewable sources. [1.6, 1.7]

> At Hönggerberg, gas is substituted with wood chips to heat buildings that lose too much energy to be connected to the Anergienetz.

Hönggerberg

At Hönggerberg Campus, most of the heating and cooling is provided by the Anergientz[i]. Furthermore, there is heating center HEZ, which formerly ran on coal and now runs on gas. ETH is considering equipping and operating the heating centre with a woodchip heating system for a few years from 2027. These endeavours are being pursued as an interim solution until all buildings can be connected to the Anergienetz. At the present time, for example, it would not make sense to connect the HIL to the Anergienetz, as the building loses a lot of energy through the façade and the system would become very inefficient if it were to be connected prematurely.

Once the necessary renovation work has been completed and all buildings have been connected, the woodchip heating system would be passed on to ERZ[ii] and operated by them. They will then use the generated heating energy to heat the surrounding neighbourhoods. These areas will continue to be dependent on high temperatures[iii]. At the same time, ETH would enter into a customer relationship with the ERZ and purchase heating energy for process heat[iv].

i) see Chapter Systems, Anergienetz

ii) Elektrizitätswerke Zürich

iii) The Anergienetz supplies supply temperatures of around 30 degrees Celsius. If older heating systems are installed in buildings, these low temperatures are not sufficient to create a standard temperature in the interior. Moreover, it will be several decades before these can be replaced, so neighbourhoods will be dependent on incineration processes to heat their homes for some time to come.

iv) Many industrial processes require so-called process heat. For certain processes, the required temperature is such that they will always be dependent on incineration as a heat generator.

Fig. [1.6] The anergy network on Hönggerberg

berg with the associated geothermal probe fields, pipe-networks and distribution centres

Buildings

There are broadly three types of occupation at ETH: research, teaching and administration. Accordingly, the three main typologies of the buildings are thus research-, teaching- and office-buildings.

Specific Uses Require Specific Adaptations
While some of the buildings in which ETH Zurich is accommodated are owned by them, others are only rented. Most of the offices, for example, are in rental units, likewise some of D-ARCH's studio rooms share a rented building with other parties. Due to the fact that research and teaching buildings often have strict and specific requirements, most of them have been commissioned by ETH. [1.8] Laboratories and auditoriums in particular are the room typologies that are extremely energy-intensive. Lecture halls, for example, may have to accommodate several hundred students. Now, since people produce waste heat, the more people there are in a room, the more energy has to be consumed to dissipate this human-generated heat and ventilate the room.

Laboratories as the Centrepiece of ETH
Laboratory construction for research and teaching, which is one of ETH's core competences, is subject to even stricter climate requirements in some cases. Furthermore, research machinery that is very energy-intensive is required aswell. It is impossible to conceive an institution like ETH without such research buildings. In order to ensure that these buildings can be maintained for as long as possible, they must be planned as flexibly as possible. Safety requirements generally become more strict over time. In the case of laboratories, it is easiest to adapt to more stringent guidelines if sufficient space is available for rising zones and supplementary building systems. The ML at the Campus Zentrum is an example of a building that can no longer serve its original purpose because it could not be adapted to today's standards. [1.7]

Processes Process a Lot of Energy
The so-called processes are something very lab-specificand very electricity-intensive. Relatively speaking, more than half of ETH's total electricity consumption is used for this purpose. The HPL and HPQ are two representative lab-buildings that stand out with their large process heat requirements. The HPL was completed in 2012 and houses Life Science since then. The animal husbandry located in it requires a specific climate that is created with large machines. The HPQ, which is currently[i] under construction, is already being described as an energy-destruction-machine. [1.7] Not only will its future operation as a quantum technology research building be extremely energy-intensive, but the construction process itself will also involve considerable investment. With the construction of the building, the third geothermal probe field will also be installed on Hönggerberg. Once the building has been completed, the heat energy for comfort demands can be drawn from the Anergienetz[ii]. However, as higher temperatures are required for process heat than the anergy network can supply, we will always be dependent on incineration processes in this sector.

i) 2022-2029

ii) see Chapter Systems, Anergienetz

> The new physics building HPQ will be an energy-destruction-machine.

Fig. [1.7] New HPQ Building. Expected to be occupied in 2029.

Supply Temperatures needed at ETH

possibly covered by Lake Water Cooling

covered by Anergienetz

- 6°C — Process cooling
- 30°C — New built Buildings heating
- 35°C — Refurbished Buildings heating
- 60°C+ — Process heating
- 80°C+ — Old Buildings heating

Electricity Distribution at ETH

Fig. [1.8] Overview on flow temperature

Labs

There Is Not Only One Kind of Lab
Although there are also some laboratories at the Campus Zenrum, the Campus Hönggerberg is particularly perceived as the home of labs and similar facilities. The meaning of the term laboratory is different for each department, or even for different institutes within the same department. Robotics labs at D-MAVT, for example, are seen more as a workshop and test room where they can test their drones of various kinds[iii]. Projects that work with electronic components at the D-MAVT need clean rooms with an overpressure in order to test the products. [1.9] Laboratories at D-CHAB that deal with chemical and biological matter are rooms that match our image of a 'traditional' lab more closely. [1.10] Guidelines define that these science laboratories are to be arranged in a grid of 7.5m x 7.5m x 3.7m, divided into a write-up zone and an experimental zone. [1.11] In reality, however, the experimental area is often extended to the writing zone. [1.12]

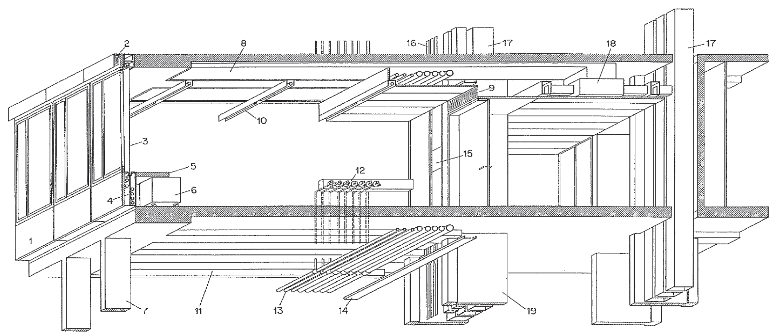


Fig. [1.9] Sectional Diagram of Standardised Labs, A.H. Steiner, Hochschulbauten ETH Hönggerberg, Zürich 1987

Specificalities of 'Traditional' Laboratories
'Traditional' scientific laboratories have very clear construction requirements that must be adhered to. Particularly in the field of cooling and heating, there are specific temperature requirements [1.11] (Fig. 1.x.) that can currently only be achieved with mechanical cooling machines and incineration processes. The so-called autoclaves[iv] is one example of equipment that requires high temperatures. In addition to the small autoclaves that exist in certain biological-chemical laboratories and are operated with electricity, there are also large centralised autoclaves at Hönggerberg that have to be operated with gas. [1.7]

iii) E.g. flying, swimming, walking drones

iv) Autoclaves are used for the sterilisation of laboratory tools. It is a pressurised container that can be sealed gas-tight and is used to sterilise materials through thermal treatment in the overpressure range.

Systems

Walche Heat Pump

The sytsem Walche, which operated for two periods of about 30 years, was a historic milestone. It was a huge heat pump system directly connected to the river Limmat. The system used motors to channel the water into the facility, where the temperature spread could be exploited to produce hot water for ETH.

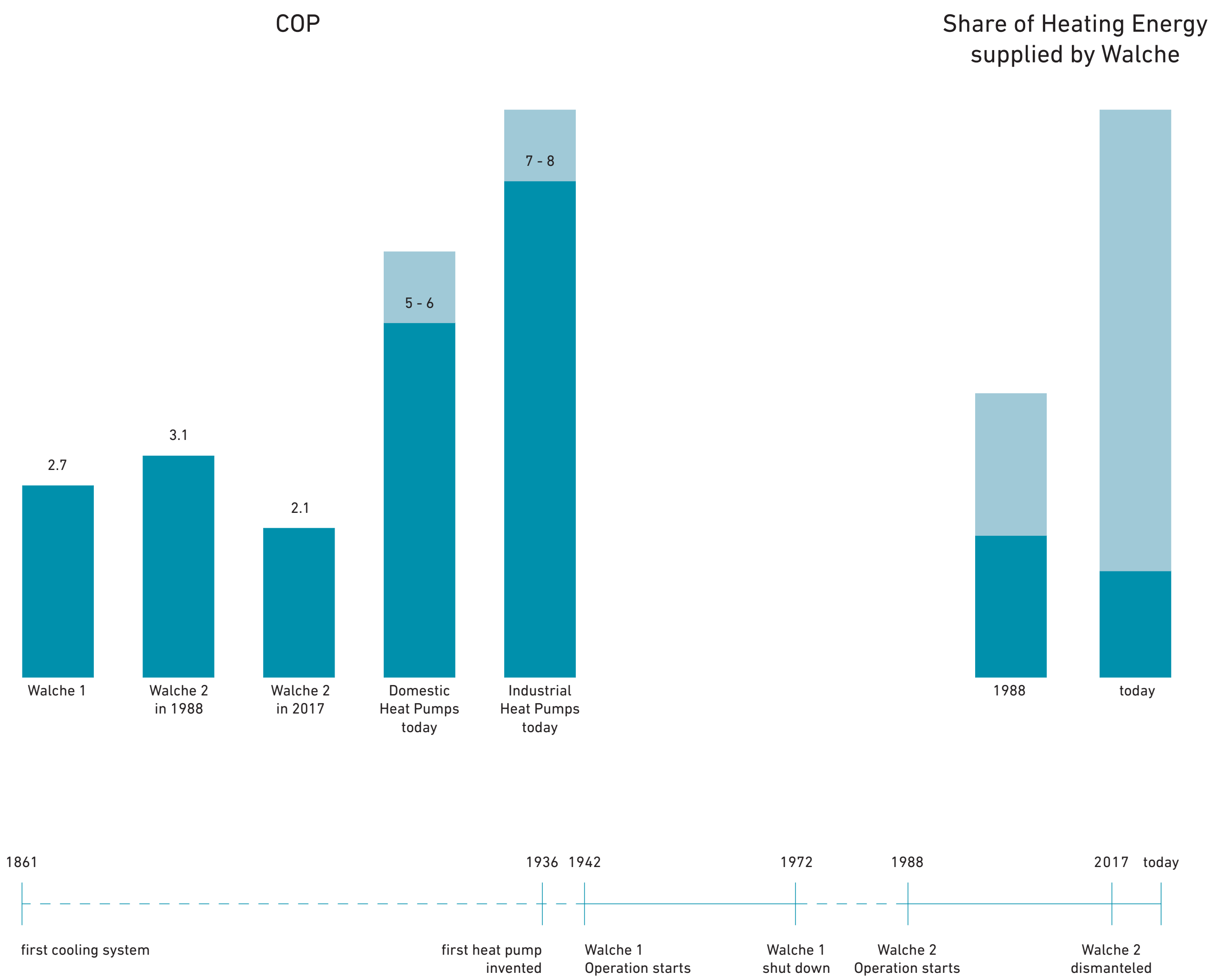


Fig. [1.10] The performance of the Walche 1 and 2 heat pumps in comparison

Invented by Mistake

Interestingly, the first heat pumps were invented not from the incentive of heating, but on the desire of cooling. When the cooling systems were invented in the mid-19th century, it was found that the warm side of the machine could be used for heating. In central and northern Europe, people generally did not need artificial cooling in the summer, however the side effect of generating heat was a very welcome one in the winter. For the next 100 years, nevertheless, oil and wood were still the energy sources that kept the population of Switzerland warm.

During and after the First World War, Switzerland suffered greatly from the difficulty of importing energy. Necessity was the mother of invention, and the use of waste heat was quickly adopted. After first experiences in the 1930s, about 35 heat pumps were installed in Switzerland between 1937 and 1945. The Walche heat pump, realized in 1942, was a daring step in the development of heat pumps, as it was the first in the world to be integrated into a district heating network. At the time, its heat output was around 6MW and it had a COP[i] of 2.7. Its location under the Walcheplatz was a strategic one, as the heat pump thus benefited from its proximity to the Limmat River, its proximity to the existing district heating pipelines and its proximity to the properties that were to be heated. After 30 years of operation, the plant was shut down in 1972 as maintenance was no longer economical. [1.13]

Let's Try Again

In the 1980s, increasing importance was attached to environmental conservation. Therefore, in addition to the economic efficiency of the buildings, the use of sustainable energy was important for the Amt für Bundesbauten. This topic was dealt with on three levels: energy saving, application of alternative systems and realization of pilot and demonstration plants. Similar to today, in the area of energy saving measures, the main focus was on increasing the efficiency of buildings and technologies. In the area of alternative systems, the aim was to find technologies that enable rational energy use and diversification of energy sources, thus contributing to environmental protection. Particular attention was paid to heat recovery systems in order to reduce energy demand to a minimum. In this context, the new Walche heat pump was handed over to ETH Zurich in 1988. Together with the use of waste heat from operational processes and the connection to the district heating network of the waste incineration plant, the Walche system was intended help replacing fossil fuels. As the largest heat pump system in Switzerland at the time, it had a maximum heat output of 13 MW and thus covered 52% of the ETH's heating demand. Around 15 GWh of electrical energy was required to operate the motors, so the system had an annual average COP of 3.12[ii]

Too Inefficient to be Viable

During the almost 30 years that the second heat pump has been in operation, great advances have been made in technology. Domestic heat pumps have a COP of about 5 to 6, in the industrial sector values of 7 or 8 can also be achieved. Unfortunately, the heat pump under the Walcheplatz could not keep up with this efficiency, and its coefficient of performance, which was praised at the time as being so groundbreakingly high, could today not be much more than 3, even if it had been refurbished. Regulatory requirements for safety and water protection have also changed. Today, the cooling agent used in heat pumps must be separated from the main water circuit by what is called a secondary circuit to prevent the refrigerant from entering the water body. This was not the case with the Walche system and it would have required a huge financial investment to separate the circuits from each other. It was therefore decided that the system was no longer economically viable and it was subsequently dismantled in 2017. [1.14]

i) Coefficient of performance, describes the efficiency of a heat pump and indicates the ratio of heat output and the electricity required to generate the latter.

ii) i.e. the heat energy generated was around three times greater than the energy input.

> A pioneering achievement at the time, economic nonsense today.

Approaches Never Change

The example of Walche shows very clearly that the idea of how sustainability should be achieved has not changed for over 30 years. Moreover, it seems as if no one has ever asked themselves whether it really makes sense to invest so much grey energy in projects that will ultimately be undone in a few decades due to their uneconomic viability.

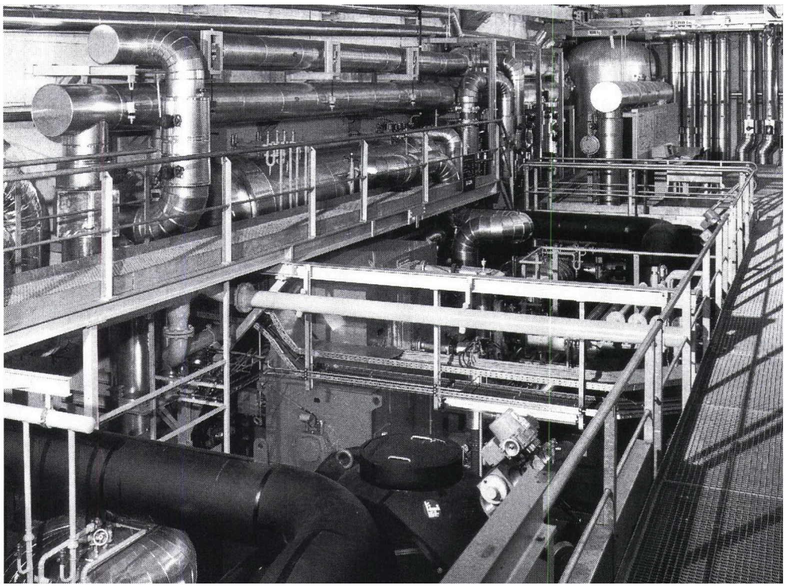


Fig. [1.11] Historical Photo of Walche 2.

District Heating

Every year, 54,000 tonnes of construction waste, 200,000 tonnes of municipal waste, 192,000 tonnes of hazardous waste and 50,0000 tonnes of slag are incinerated at the Hagenholz waste incineration plant. [1.15, 1.16] The heat that is generated is channelled underground through the entire city of Zurich and is used to heat buildings and other processes.

Burning Waste for Sustainability
It is expected that the emissions resulting from the incineration of waste[i] cannot be completely eradicated by 2050. It is estimated that 12 million tonnes of CO2e will still be emitted and that the net zero target can only be achieved with the help of so-called NET[ii]. It is assumed that the amount of waste throughout Switzerland will remain roughly the same or decrease slightly by 2050. [1.3] This means that no new waste incineration plants will be built, but existing plants will be optimised and expanded as district heating networks. In the city of Zurich, another area of roughly the same size as the existing one is to be connected to the District Heating network and it is assumed that large parts of the city's heating demand will be covered by it.

Fig. [1.12] Amount of Waste needed to cover ETH Zentrum's Heating Energy Demand

> The federal government expects 12 million tonnes of CO2 emissions in 2050, most of which will come from waste incineration.

ETH Promotes Central Heating Systems
ETH Zurich has been connected to the city's district heating network for decades. At the Campus Zentrum, supply temperatures of 80 degrees Celsius can be drawn directly from the waste incineration plant in the form of steam. The steam is first channelled into the ML building, where it is decompressed with the help of an expansion facility. This plant, operated by ETH, supplies heat for the ETH buildings and around 150 other buildings in the Hochschulquartier. However, ETH does not wish to be a district heating supplier in future and will therefore hand over this plant to ERZ and become a customer of the latter. [1.7, 1.17]

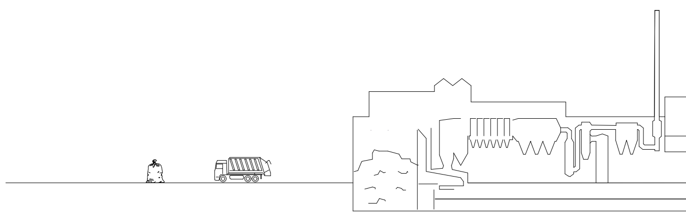


Fig. [1.13] Overview on heating and cooling supply of ETH Zentrum today and in the f

Mechanical Cooling Systems

Ideally, heating and cooling circuits of a building complex are linked. The large cooling demand of the Campus Zentrum is currently covered by mechanical cooling machines located in the ML, CLA and CHN buildings. [1.18] The massiv waste heat produced equals around 1.5 times the amount of heat that the Walche Heat Pump could have provided. [1.7]

Centralising is Increasing Efficiency

In the past, these cooling systems operated on a decentralised basis and were therefore only able to provide punctual output, which significantly reduced their efficiency. Today, not only the cooling system, but he entire air conditioning is centralised and connected via a star-shaped system. [1.18] It works similarly to the Anergienetz[iii] at Hönggerberg. The only difference to the system at Hönggerberg is that a seasonal shift[iv] is not possible.

The Future Is Wet

These recently commissioned cooling systems consume a lot of electricity. Their lifespan is estimated at around 15 years, after which they may be used in reduced operation for redundancy. By around 2035, Lake Zurich[v] will ultimately become the main source of cooling-energy for the ETH Zentrum. The pipes for lake water use will be installed as part of the expansion of the Stadelhofen railway station. The existing pipework within ETH can continue to be used as before. [1.19]

i) also from agriculture and large-scae industrial processes

ii) see Chapter Strategies, Excursus: Negative-Emission-Startegies

iii) see Chapter Scales, Hönggerberg and Systems, Anergienetz

iv) see Chapter Systems, Anerguenetz

v) see Chapter Systems, Lake-Water Use

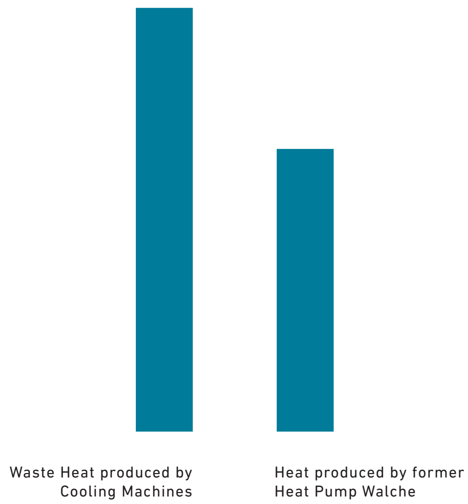
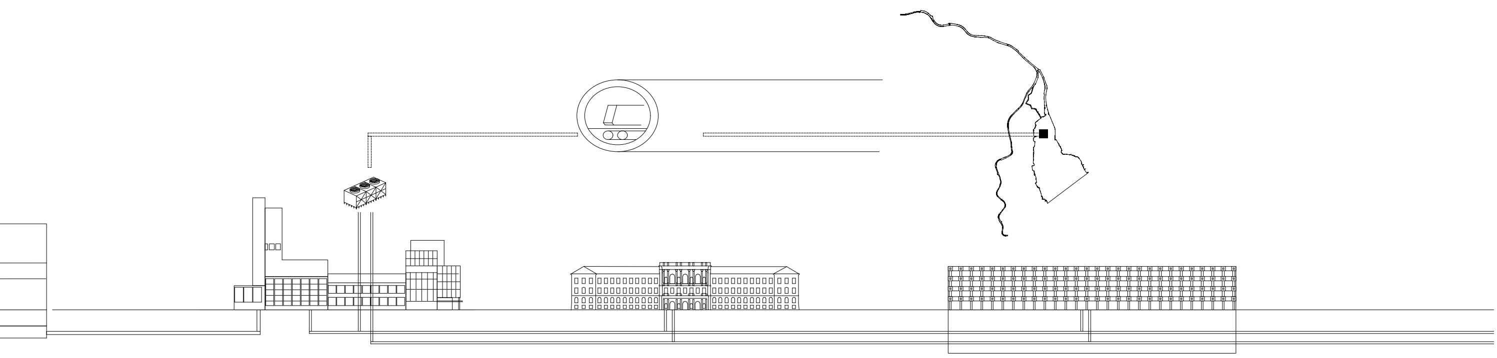


Fig. [1.14] Waste heat produced by Cooling Machines compared to the heat production of the Walche heat pump



Excursus: Electricity

ETH needs 104'607'233 kWh/a. The institution itself produces 967'733 kwh/a with solar panels, meaning we consume a lot of electricity but only produce a marginal part of it. At the same time the PV potential is not fully realised. [1.20]

Shouldn't we be a role model? Cf. UCPH, which sees itself as a link in the sustainability strategy of Copenhagen, Denmark and the EU.

Fig. [1.15] Comparison between ETH's electricity need and the selfproduced part of it.

Lake Water Use

In the near future, when cooling energy will be more important to the City of Zurich than heating energy, Lake Zurich will play a major role. As part of the 'Cool City' project, an access to the lake is to be realised in 2035, allowing water to be pumped out of the lake and distributing its cold temperature to a large part of the city.

Seizing the Moment

The project, commissioned by E360, takes the opportunity provided by the extension of the Stadelhofen station to create direct access to Lake Zurich. The water will be drawn in from below the thermocline[i] at a depth of 20-40 metres and routed via Stadelhofen station towards the main station through pipes that will be located in the tunnel of the new fourth track. [1.21, 1.22]

> Cooling will be our biggest concern in the future.

Cooling the Hochschulquartier

At the spot between Stadelhofen station and the main railway station, where the channels are located under the Hochschulquartier, some of the water will be pumped upwards with the help of electrically operated pumps, where its temperature can be transferred to a refrigerant and used to cool the universities via a separate circuit. About 1 degree Celsius is lost when the water is diverted and another 1 degree when it is transferred. However, the temperatures are still low enough to create a pleasant climate for all the academic buildings. [1.7] After use, the water can be released into the Limmat at an only slightly higher temperature. There are currently three cooling facilities in the university area that are equipped with mechanical cooling systems. This existing star-shaped cooling network, between the ETH, UZH and USZ buildings, will function as the separate circuit mentioned above. [1.18]

In winter, with the help of a heat exchanger, the lake water could theoretically also be used for heating, but ETH itself has not yet expressed such endeavours.

Please Do Not Disturb

In order not to disturb the balance in the lake, a maximum usable amount of water that can be pumped out of the lower half of the lake has been defined. However, this amount will decrease as the lake heats up due to climate change. The share required to cool the ETH is approx. 3%[ii] at current values. [1.23, 1.24]

i) Boundary zone between warm surface water and cold deep water, below it the temperature is between 4 and 10 degrees Celsius

ii) own calculation based on soruce [1.23, 1.24]

3% of the lake water that is avaliable for cooling the city of Zurich will be used for ETH Zentrum.

Fig. [1.16] Amount of Lake Water needed to cover ETH Zentrum's Cooling Demand

Anergienetz

The Anergienetzwerk of ETH is considered the new flagship in terms of sustainability and is always at the forefront of all reports.
It currently covers 95% of heat demand and 63% of cooling demand. In 2050, it is expected to cover 90% of heating and 80% of cooling. [1.25]

Sources and Masses
To ensure the functioning of an anergy system, two essential constituents are required. Firstly, it needs a heating resp. cooling source and secondly a storage medium, a battery so to speak.

In the case of Hönggerberg, the heat sources are the large laboratories and computer rooms, whose waste heat is fed into the Anergienetz. Theoretically, auditoriums and similar rooms could also be connected, but this is currently not necessary as there is generally too much waste heat on campus rather than too little. In contrast, superfluous cold very rarely occurs.

The battery resp. the storage medium is the ground. This thermal mass[i] absorbs heat in summer and stores it so that it can be reused to heat the connected buildings in winter. As the heat is used up, the ground is transformed from a heat storage medium into a cold storage medium. In summer, the process is then reversed and the cold is used to air-condition the buildings. [1.25, 1.26]

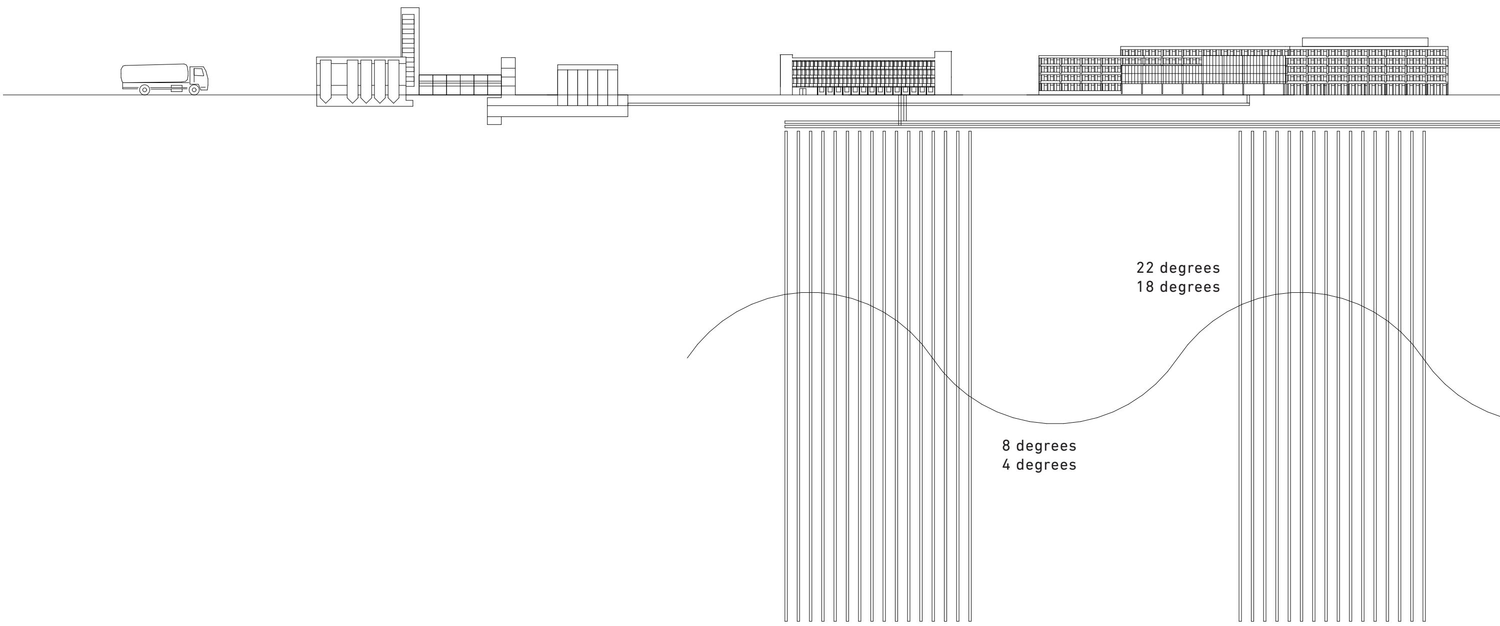


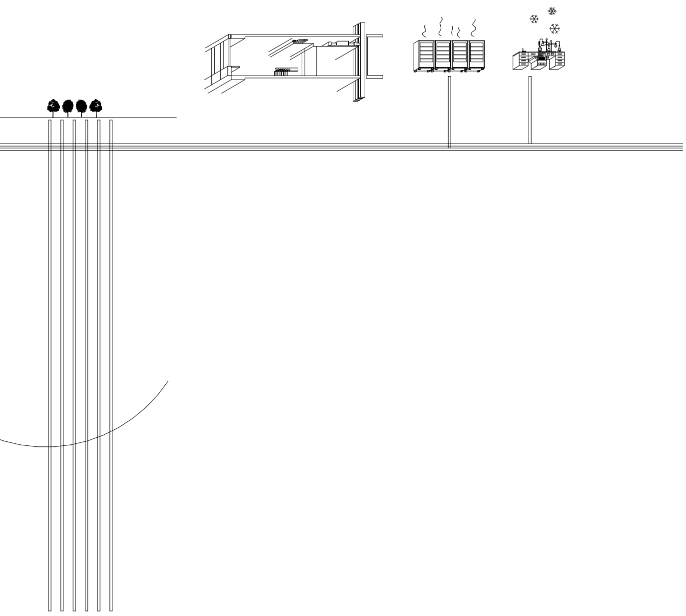
Fig. [1.17] Overview on heating and cooling supply of ETH Hönggerberg through gas and processes

Profiting From A Temperature Spread

This underground technological system spreads across the entire Hönggerberg campus. There are geothermal fields at various locations that are connected to a dual pipe system. This pipework system has a hot and a cold circuit, which are separated from each other and the temperatures of which must always differ by 4 degrees Kelvin. To be more precise, in September the temperatures are 22 and 18 degrees Celsius and in May 8 and 4 degrees Celsius.

The geothermal probes are located at a depth of 200 metres and are arranged in a grid of 5 metres x 5 metres[iii]. Most of the ground is rocky, but in a partial area of the geothermal probe field in the south-east of the Campus, next to the HCI building, there is an underground watercourse that restricts the storage of heat[iv]. Although this heat loss marginally restricts the efficiency of the system, it is not a major concern when considering the overall supply. Three of these geothermal probe fields are already in operation today, one is under construction and two more are in planning. [1.25, 1.26, 1.7]

In principle, new energy sources can also be tapped at any time. For certain buildings, however, it does not yet make sense to connect them to the grid and heat them with anergy. This is the case with the HIL building, for example. Because it loses so much heat through the building envelope, connecting it before renovation would be a complete waste of energy and would cause the Anergienetz to become extremely inefficient.



> The Anergienetz can heat and cool everything, except experiments.

Where The Real Crunch Lies

In principle, the concept sounds relatively simple. Yet much more tactical efforts and strategies are actually required to ensure that the system works. If the heat storage is not balanced throughout the year, i.e. not all the heat or cold is used up, this can lead to overheating or undercooling of the thermal mass. As a result, it becomes even more difficult to maintain the balance of heat and cold in the following cycle, creating a vicious circle. At Hönggerberg, for example, there tends to be too much waste heat, as mentioned above. Strict monitoring is required to decide how much of the waste heat should be fed into the Anergienetz and how much should be released through free cooling[v]. If all the energy were always stored in the ground, it could not be used up completely even in a very cold winter. Then in the following summer there would not be enough cold to cover the demand, not lastly because cold is generally too scarce.

All in all, comfort heating and air conditioning are still easily provided for a while. The challenge that ETH still faces, however, is the energy required for processes[vi]. Due to the specific supply temperatures, this will never be covered by the Anergienetz[vii]. However, if for this reason it were decided to move the laboratories away from Hönggerberg, this would in turn have an immense impact on the production of waste heat, without which the Anergienetz would reach a tipping point and would no longer function. However, the current tendency is for processes and laboratories to move from the Zentrum to the Hönggerberg and the energy that cannot be supplied by the Anergietz is to be substituted by either mechanical cooling or heat from incineration processes.

i) Thermal mass is the ability of a material to absorb, store and release heat
ii) see Fig. 1.6, page 17

iii) A probe in the ground has a thermal influence range of approximately 5 metres.

iv) If the water touches the geothermal probe, the heat is transferred to it and transported away.

v) Approach to reducing the temperature in a building or data centre by using naturally cool air or water instead of mechanical cooling.

vi) see Chapter, Scales, Buildings/Labs

vii) see Chapter, Scales, Buildings/Labs

Strategies

2000-Watt-Society

Reducing Energy-Consuption by 65%
The aim of the 2000-watt society is to limit Switzerland's primary power consumption, or conceptually even the whole world's, to 2000 watts of continuous power. The world's average consumption in 1990 was 2000 watts. If this value were to be maintained, it would be possible for the world to achieve the 2-degree target of the Paris Agreement. In 1990, Switzerland had an average consumption of 6700 watts per person. Today's consumption in Switzerland lies at 4,400 watts/person [1.27] and at ETH at 4,700 watts/student resp. FTE[i]. [1.24, 1.2] This means that we must greatly reduce our current consumption to achieve these goals. Additionally, it could be considered to reduce even further and to implement a 1000-watt society to compensate for Switzerland's above-average energyconsumption of the past decades [1.28].

> The only measures that are being implemented are efficiency measures, as comfort is something that people do not want to sacrifice.
> Usually buildings are made efficient through demolition and new build.

Systemic Change for Behavioural Change
Since 2008, the 2000-watt society has been anchored in the City of Zurich's municipal law as a long-term goal for 2070. The concept foresees that 75% of the 2000 watts will originate from renewable sources and 25% from fossil sources, with the fossil share being compensated. The principles of the efficiency, consistency and sufficiency strategy[ii] lay the foundations for the action proposals of the 2000-watt society. [1.29, 1.30]

This concept is interesting, not only because it pushes Switzerland forward in terms of technological developments, but especially because it encourages people to rethink their consumption and reduce it. Studies show that the necessary behavioural adjustments were hardly noticeable by the test subjects, which is an important basis for achieving a lasting change in behaviour. Nevertheless, systemic changes are essential to enable every individual to adopt sustainable behaviour without restrictions.

Only Partly Complete Calculations
The energy requirement foreseen by the guiding concept of the 2000-watt society amounts to 2000 watts at the primary energy level. Primary energy includes all the energy used to produce the energy carriers used, i.e. wood, natural gas, solar energy, etc. In this way, the energy required to operate the building can be calculated very precisely. An benefit of this method is that it can also be scaled up to calculate consumption per neighbourhood, city or for the whole of Switzerland. Furthermore, primary energy is always calculated locally and per year. [1.31] For ETH as an institution, such an approach would entail the following gaps: Since ETH also consumes energy at external locations, their part is quickly overlooked or declared as too marginal.

Considering the construction, demolition and disposal of buildings, the concept also raises questions. This is because the grey energy[iii] of a building is not fully taken into account in the calculation.

i) own calculation based on annual report 2022; should be max. approx. 600-700W, services + industry + some transport [1.2]

ii) Efficiency: producing more with fewer resources,
Consistency: change in production, only using resources and technologies that don't impair ecosytsems,
Sufficiency: change in human life-styles to save resources

iii) The grey energy of a product is the total energy required for its manufacture, transport, storage, sale and disposal"; source: Wikipedia, grey energy

Although a holistic view and changes on the three different levels[2] are being aimed for, the 2000-watt target primarily favours the efficiency approach. Most people are afraid of having to give up their comfort, so the focus is on building more energy-efficiently, producing energy even more efficiently and insulating buildings better. Unfortunately, due to their performance, old buildings that have stored a lot of grey energy are usually demolished and replaced instead of being refurbished and extended. The evaluation of buildings is reduced to mere figures; if a certain value is exceeded or not reached, an old building has to be replaced. [1.41] In order to prove the performance of buildings, the 2000-watt society relies on various sustainability labels, which are addressed in the next chapter. [1.31]

Naturally, pure economic interests also play a role in the decision-making process, as new buildings can be sold and rented for more money than renovated properties. Grey energy, which accounts for at least half of the emissions that can be attributed to a building over its life cycle, is therefore currently not given any importance. However, this is not the only reason why we should rethink our current building policy, but also because approaches that focus purely on efficiency have historically always had a rebound effect[4] and have therefore not been able to establish themselves over the long term. [1.32, 1.33]

4) Once efficiency has been increased, users' behaviour changes and they consume more. The original savings are therefore cancelled out.

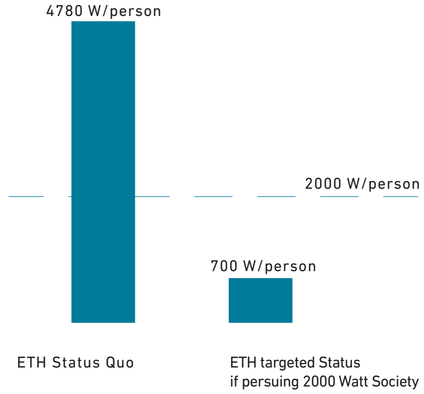


Fig. [1.18] Comparison between ETH status quo energy-use and projected values if the concept of the 2000-watt society were to be applied.

Excursus: Living Labs

The so-called 'Living Labs' are intended to test the current research being conducted at ETH in actual projects. This is realised in a wide variety of forms: from participative methods by urban planners, to solar houses with vaulted ceiling elements, to reusable building materials that are made identifiable by using QR codes.

From now on, ETH's newly built infrastructure will always serve as a platform for testing in-house research.

Fig. [1.19] Living Lab of the Architecture and Building Systems Chair

Sustainability Labels

In Switzerland, as required by the 2000-watt society, and within the ETH aswell, the Minergie and SGNI labels are widely used to assess and standardise buildings. These labels are generally designed to ensure that buildings can be operated as efficiently as possible. In the case of ETH, the labels are not used because of their association with sustainability, but rather because the requirements are generally known and communication with planners can therefore be simplified. [1.34]

Origins of Sustainable Buildings
The history of sustainability labels began in the 1970s with Rudolf Kriesi, the developer of the now well-known Minergie label. The standards are designed in such a way that the climate in the house is almost completely isolated from the environment and has the tightest possible envelope. Inside, technical equipment is used to create a climate of its own. [1.35]

Thinking inside the Box
The very tight building envelopes to prevent major heat losses trough the façade make sense for certain types of buildings, but can also have some disadvantages for others. In the context of ETH, for example, various laboratories cannot utilise these standards as they are not compatible with safety requirements. Due to these standards, the building volumes are required to be as compact as possible, without offsets in the façade and with the most efficient insulation possible. The result is predominantly very rationalised architecture with simple shapes. Furthermore, due to the standards, many parts of the building can only be constructed in concrete and it is not possible to switch to more ecological materials. [1.36]

Lost Interaction Through Automation
Automated building ventilation systems are also always a requirement for this type of sustainability certification. High air exchange rates, which always occur in labelled buildings, can cause the air to become very dry, which in turn leads to a loss of comfort. Additionally, automation systems inevitably involve technical equipment that ages quickly and therefore needs to be maintained or soon replaced. The interaction of users with the building suffers equally from the use of automated systems and the individual care moment for the building and its surroundings is lost. In the most direct case, this also leads to a loss of comfort.

Label Maker Interests
In order to obtain certification, a financial effort is always necessary. In the case of Minergie, for example, the certification is expected to cost at least CHF 24,000, with this price increasing with higher volumes. The label makers therefore have a very direct monetary incentive to design the labels in such a way that they sell best and not necessarily in such a way that they produce the most ecological buildings possible. [1.36]

Minergie buildings consume up to 200% more energy than predicted.

Thinking outside the Box
The Minergie standards and the passive house concept are two very different approaches to designing an environmentally friendly concept for buildings. It is important to realise that there is probably no one perfect solution to environmental issues in general; instead, solutions should be adapted specifically to the location and circumstances of the site. In the construction industry, however, the Minergie strategy in particular has become established and is used everywhere today. In other words, the favoured strategy is of technical nature which means one doesn't have to deal with one's surroundings. However, this also means that you are not allowed to interact with the building at all. A study shows that 40% of Minergie buildings have a higher energy consumption than predicted, in some cases it can be up to 200% higher. [1.37] This is due to the fact that the occupants are not entirely happy with the climate in the building and adjust it manually. For example, despite automatic ventilation, windows are left open for long periods of time and a lot of energy is lost through free cooling. In such cases, a spatial-social solution such as that offered by Schäfer's passive houses would probably be more appropriate. [1.38]

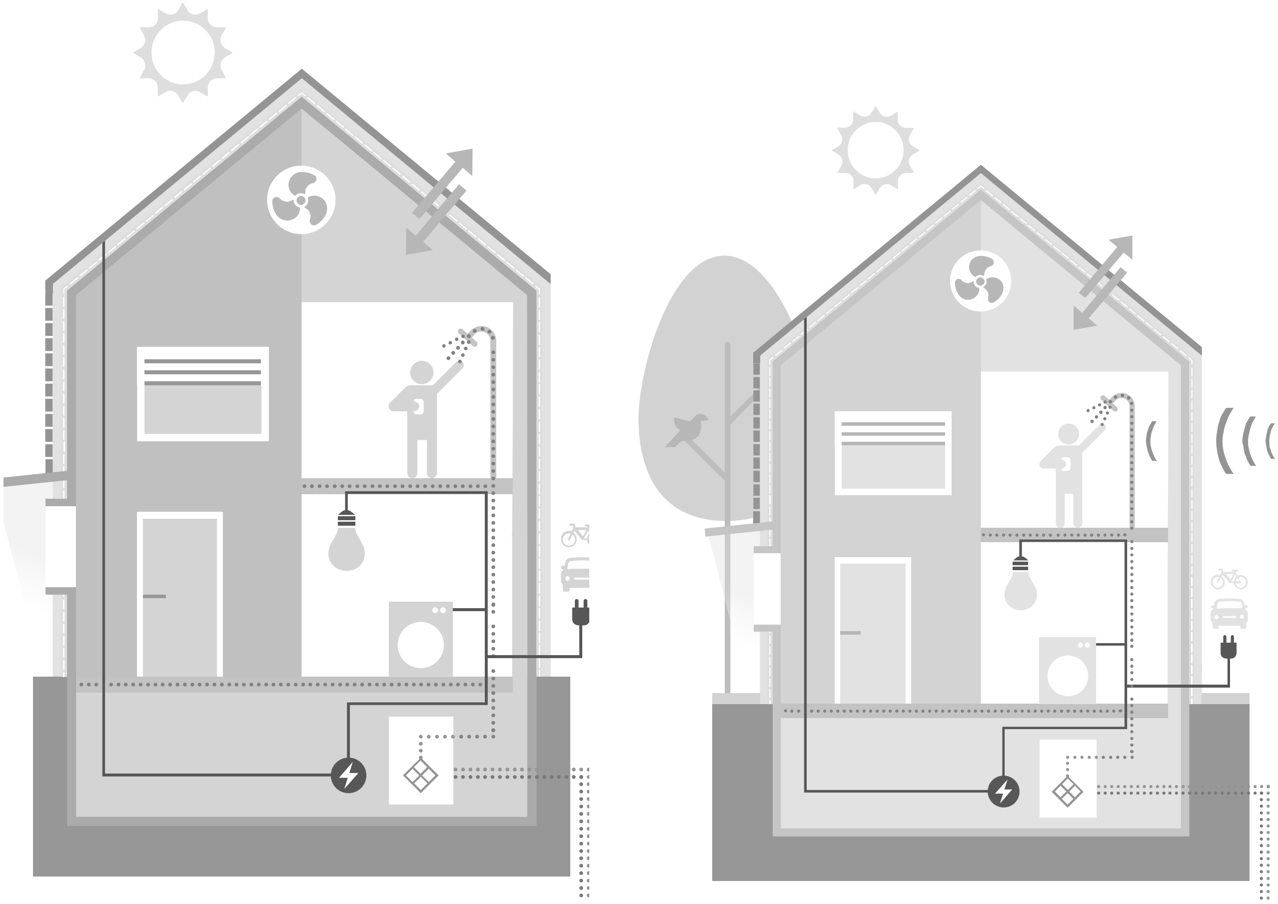


Fig. [1.20] Schemes for the Minergie and Minergie-ECO houses

Excursus: Negative-Emission-Technologies (NET)

Negative emission technologies are expected to reduce Switzerland's CO2-eq emissions by around 12 million tonnes.

Biological and technical processes used in large waste incineration plants or industrial facilities are expected to be able to process 5 million tonnes of CO2eq domestically. The remaining 7 million tonnes of CO2eq are to be transported and processed abroad. An example of this is the geological storage of CO2 in icelandic ground. The CO2 is transported via pipelines from all over Europe to Iceland or the north sea where it is injected deep into the bedrock. [1.3]

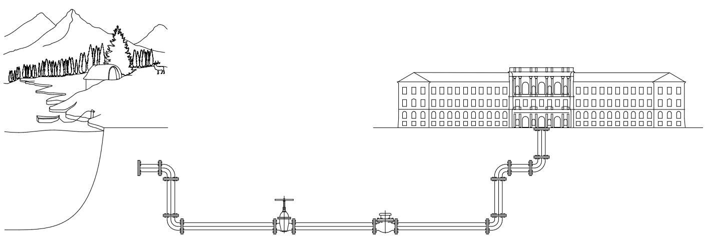


Fig. [1.21] Illustrative representation of the NET-technology in Iceland

Designing Behaviour Change

How much is enough? Sufficiency poses the question of how much people need in order to lead a good life that conserves resources. It is about far more than just using the most efficient technologies possible.
People lead a sufficient lifestyle when they consciously align their behaviour with what is really necessary for a good life and not what is the maximum imaginable.

Bundesamt für Kultur

Changing our consumer behaviour is an important part of global efforts to combat climate change. In order to promote change in behaviour patterns in the long term and define appropriate measures for an academic setting, one must first become aware of where the specific behaviour is taking place and which actors are doing the behaviour. Thereafter, one can identify what needs to be changed and what the appropriate intervention options are. The IARU has conducted a number of case studies and defined nine intervention options. These interventions can in turn have an impact on three personal levels: Capability, Motivation and Opportunity. In order to change different behavioural patterns, physical and psychological skills must be imparted, reflective and automatic motivation must be enhanced and physical and social opportunities must be offered. [1.39]

INTERVENTION	CAPABILITY		MOTIVATION		OPPORTUNITY	
	Physical	Psychological	Reflective	Automatic	Physical	Social
Education		●	●			
Persuasion			●	●		
Incentivisation			●	●		
Environmental Restructuring		●		●	●	●
Restriction					●	●
Training	●	●			●	●
Coercion			●	●		
Modelling		●	●	●		●
Enablement		●	●	●	●	●

Education[ii]
In the context of education, possible formats of knowledge transfer include printed media such as posters, flyers, brochures, etc., digital media such as e-mails and websites or verbal communication such as specific advice, lectures or workshops. What is important to understand is that the best way to communicate depends heavily on the type of environment and must be designed accordingly.

Persuasion[iii]
Persuasion often involves awareness-raising campaigns with information about the negative consequences of inappropriate behaviour. Generally, students and employees have been found to act more positively when they see the problem as a personal one and they feel they have some control over it. Direct persuasion can take the form of graphs, tables, motivational texts, pictures, interactive displays and printed or electronic material. Verbal persuasion in the form of peer-education has been shown in studies to be particularly effective. It is also desirable to formulate sustainability as a kind of institutional motto. This anchors the topic as a shared value and promotes its importance. In principle, however, persuasion alone is not enough to have a major influence on energy consumption behaviour and should be combined with other techniques such as incentivisation, environmental restructuring, modelling, enablement and education.

Incentivisation[iv]
Unlike in private households, students and staff at universities are not financially responsible for their energy consumption. Incentivisation is intended to combat this obstacle by creating the expectation of a social or financial/material reward. The success rate of this approach varies widely in studies, so it is important that the type of incentive is critically evaluated before it is implemented. In general, however, it can be said that public rewards outperform private rewards and that social rewards outperform monetary and material rewards.

Environmental Restructuring[v]
Environmental restructuring refers to the physical and social change of the environment to encourage a specific behaviour. This can for example take the form of posters, electronic feedback devices, retrofitted technology and technology automation, resulting in the establishment of a context, altered norms, social norms or working ethos that encourages energy saving behaviour. The automation of technologies, in particular, holds considerable potential for energy savings. Nevertheless, the rebound effect is a major threat here. The reduced costs reinforce the blind reliance on the efficiency of buildings and minimise the motivation to engage in energy saving actions.

Restriction[vi]
Restriction refers to a set of rules that prevents an individual from performing a specific behaviour and instead encourages a different behaviour. An example of this could be changing the opening hours of buildings, as it takes a lot of energy to keep a building open and operating at night. However, this is a rather unpopular method since it is preferable to allow people their liberties rather than limiting them.

Training[vii]
Few of the measures that students and staff can take require a significant change in physical capabilities. Furthermore, energy management in universities is usually centralised and therefore they rarely have the opportunity to participate in complex measures to reduce energy consumption. Normally these can only be carried out by building or facilities managers.

Coercion[viii]
As it is not desirable to create negative reinforcements, there are few studies on coercion. However, some universities have introduced a charging and reward system where departments that fail to reduce energy consumption are penalised financially. However, there is no significant evidence of effectiveness as the penalties tend not to be felt at an individual level.

Modelling[ix]
Modelling is typically introduced as part of a holistic behaviour change programme. The method is particularly effective when the positive behaviour is demonstrated by people who already function as role models in their context, e.g. professors or senior researchers. Modelling also includes messages that strengthen the group identity, which in turn leads to the individuals putting in more effort to achieve the common goals. This can be done, for example, through shared stories or public displays. In the best case, the modelling method should lead to the normalisation of energy-saving measures, which in turn ensures their longevity.

Enablement[x]
Enablement is a particularly successful intervention, especially when it is part of a behaviour change initiative. The method can include, for instance, energy dashboards that allow employees and students to control their electronic devices automatically. Another straightforward example is giving employees access to power sockets or making the schedule flexible. Enablement is essentially about giving people control over their environment.

Overall, it is important to understand that on their own, these approaches are likely to fail. In combination, however, the measures complement each other and major reductions in energy use can be made. [1.39, 1.40]

i)International Alliance of Research Universities

ii) Increasing knowledge or understanding

iii) Using communication to induce positive feelings or stimulate action

iv) Creating an expectation of reward

v) Changing the physical or social context

vi) Using rules to reduce the opportunity to engage in a target behaviour

vii) Imparting skills

viii) Creating an expectation of punishment or cost

ix) Providing an example for people to aspire to

x)Increasing means / reducing barriers to increase capability or opportunity

Conclusion

ETH is Switzerland's shining example. Therefore, it is essential that it is a good role model for Zurich, Switzerland and the whole world. It invests a great deal of time, energy and money in driving forward various scientific and technological developments. So it is not surprising that it is also making a major and valuable contribution to the future in the field of environmental technology. ETH's energy operations are thus very efficient and the applied systems appear to be sensible with regard to climate change. The Anergienetz and the future lake water use are very resilient and promising systems. However, they have their limits and require a huge infrastructure to operate them. District heating also seems like a rational way to heat the campus, as it uses resources that are already there and would be burnt anyway, but at the same time it seems unambitious to assume that society will always produce waste.

What if Zurich does not produce anymore waste? Is ETH freezing?

The idea of a zero-waste future actually seems like a very aspirational goal. But what if we hinder this future today because we limit ourselves to specific systems that supply us with a specific type of energy? Will it still be possible for us to make such a major shift in paradigm when the time comes? These thoughts can be asked not only about district heating, but also about many other efficiency driven developments on which we base our life styles today. What is a good solution today may no longer work in the future because the systems are not flexible enough. New efficient technical solutions will then have to be found.

What if efficiency was not part of our strategy?

Historically, the pursuit of efficiency has always had a rebound effect. So we have to ask ourselves, is increasing efficiency really always the solution or is there a saturation point that cannot or should not be exceeded? It is not only a question that an institution should address, but one that is directed at society as a whole. Certain attitudes towards action strategies seem to be deeply rooted in our culture and are closely linked to our idea of comfort and prosperity. Among other things, this is one of the reasons why Minergie has established itself as the best-known label - it represents a fully automated luxury that relieves us of all responsibility and effort (to engage with our environment). Yet it could be that we are holding on to an outdated image of the future that does not reflect the current problems. It would therefore be worthwhile rethinking the current behaviour and decision-making patterns and considering new approaches in our strategies.

What if sustainability did not come in the form of a plastic box?

Today's idea of sustainable buildings creates high-tech boxes made of concrete and plastic. Houses are created to be machines and not to be inhabited by people. However, when people can adopt a place and engage with their environment, they begin to identify with it and care about it. ETH has the unique opportunity to sensitise and educate its members on this topic. In combination with the role model function that the institution has for Switzerland and that its professors and senior researchers have for the younger generation at the school, it is possible to restructure the academic environment in such a way that ecological behaviour is naturally anchored in everyday life. Buildings can be reorganised in such a way that only the smallest possible part needs to be conditioned by machines and the rest is controlled by the users themselves to the best of their knowledge and belief. But for people to be able to bring their internalised awareness to light, they must be enabled to show that they can do it.

What if ETH trusted its people?

Future Strategies for ETH's Building Stock

In an environment of escalating sustainability concerns, ETH faces the imperative of reconfiguring its spatial development effectively. This chapter provides thorough insights into how additive construction strategies and the current building stock can collaboratively forge more future-proof solutions.

Amid the growing imperative for sustainability, a critical reassessment of ETH's spatial development is essential. This chapter aims to provide in-depth insights into how additive construction strategies and the current building stock can collaboratively contribute to more future-proof solutions.

As a pivotal institution of major relevance in Zurich, Switzerland, and a significant contributor to the city's built environment, ETH holds a crucial role in shaping an urban landscape prepared for the future. Against the backdrop of the urgent need to address climate change, the manner in which ETH develops and provides buildings and infrastructures becomes paramount.

Processes of ETH's Real Estate Development
To gain a comprehensive understanding of ETH's practices in developing usable space, the initial step involves an interrogation of the decision-making processes. This entails placing regulations, guidelines, actors, and target values of ETH's real estate management into perspective. Such an analysis reveals dependencies and unveils a systematic neglect of certain development strategies.

Real Estate Development Strategies in Comparison
Building upon this insight into procedural characteristics, the chapter proceeds to undertake a comparative analysis of various normative strategies of real estate development. Examining the benefits and deficiencies of different interventions - refurbishments, replacement construction, or additive extensions - primarily from the perspective of energy demands, offers initial conclusions on the desirability of specific strategies. The discussion expands by considering operational energy demands, investments into grey energy, compactness, and lifecycles to present a comprehensive image of energy-intensity. Importantly, the idea of expansion is woven into this discussion, considering the possibility of needed spatial growth for the institution.

Externalities of Construction and Land Use
Moving beyond the narrow focus on energy use, the subsequent section broadens the perspective. It places different development strategies within the context of diverse externalities, encompassing aspects such as land use, biodiversity, and the vital functions of soil and water. This enriched discussion enhances the understanding of the implications of various development strategies.

In the realm of energy use and within a broader conception of sustainable development practices, the efficient utilization of the existing building stock emerges as a pivotal factor. The chapter concludes with a broader reflection on ETH's processes of space production, amplifying the opportunity presented by the existing building stock. In doing so, it opens avenues for critical thinking toward current practices, allowing for the envisioning of new approaches for more future-proof solutions. This chapter, therefore, serves as a catalyst for introspection and innovation, encouraging a proactive stance toward sustainable spatial development at ETH.

Processes of ETH’s Real Estate Development

Normative Development Strategies

In order to understand how ETH Zurich deals with its building stock, it is worth taking a look at the general spatial development processes of the institution. At various scales and hierarchical levels, values are determined, goals are set, strategies are drafted and finally decisions are made, which have a direct or indirect impact on the spatial development of ETH Zurich.

The starting point for spatial development is the Overall Spatial and Financial Concept [2.1] (Räumliches und Finanzielles Gesamtkonzept, RFGK). This concept is commissioned by the ETH Board as one of the federal government's BLOs (Bau- und Liegenschaftsorgan) every four years and consequently developed by the Real Estate Division (Abteilung Immobilien), aligning it with the ‚Mid-Term Financial Planning’ [2.2] (Mittelfristige Finanzplanung, MFP) as well as existing ETH strategies. Although many different ETH strategies exist, the overarching priority seems to be the qualitative and quantitative development in teaching, research and technology transfer. Furthermore, thematic priorities are defined that are intended to lead the university into the future: Information technology, medicine and health, materials and research technologies, as well as responsibility and sustainability. [2.1]

ETH's space requirements (Flächenbedarf, HNF m^2) seem to be the most important metric for the future of the institution’s real estate management. To calculate the space requirements, department-specific average values for workspace are used. Therefore chairs and departments influence not only the thematic development of ETH Zurich but also directly the spatial expression of that development. The space requirements are then extrapolated on the basis of the projected number of students and professors. Already today, ETH is said to have too little space. Not only because of increasing numbers of students and professorships, but also because a flexibility reserve is foreseen in order to have space available when renovations are necessary (Rochadeflächen).

However, the image of a completely overcrowded and overloaded ETH must be questioned if one considers the analysis covered in the chapter Future for Rooms. It will be illustrated, to what degree ETH is not using its existing spaces efficiently as of now, thus generating a disproportionate spatial demand. In this chapter, on the other hand, general strategies will be interrogated, which would favorably come into play in the case of legitimate spatial demands. Strategies will be put into perspective qualitatively, without assuming a specific magnitude of space needed.

The prevailing erroneous self-assessment by ETH that their building stock is already fully utilized is possibly one reason why the provision of new space is systematically decoupled from the management of the existing building stock. Looking at the process of ETH‘s real estate development (Fig. [2.1]) one has to

> «The development of space requirements from work and teaching areas as well as their associated social, storage and infrastructure areas follows ETH Zurich‘s claim to excellence in teaching, research, knowledge and technology transfer.»
> ~ RFGK

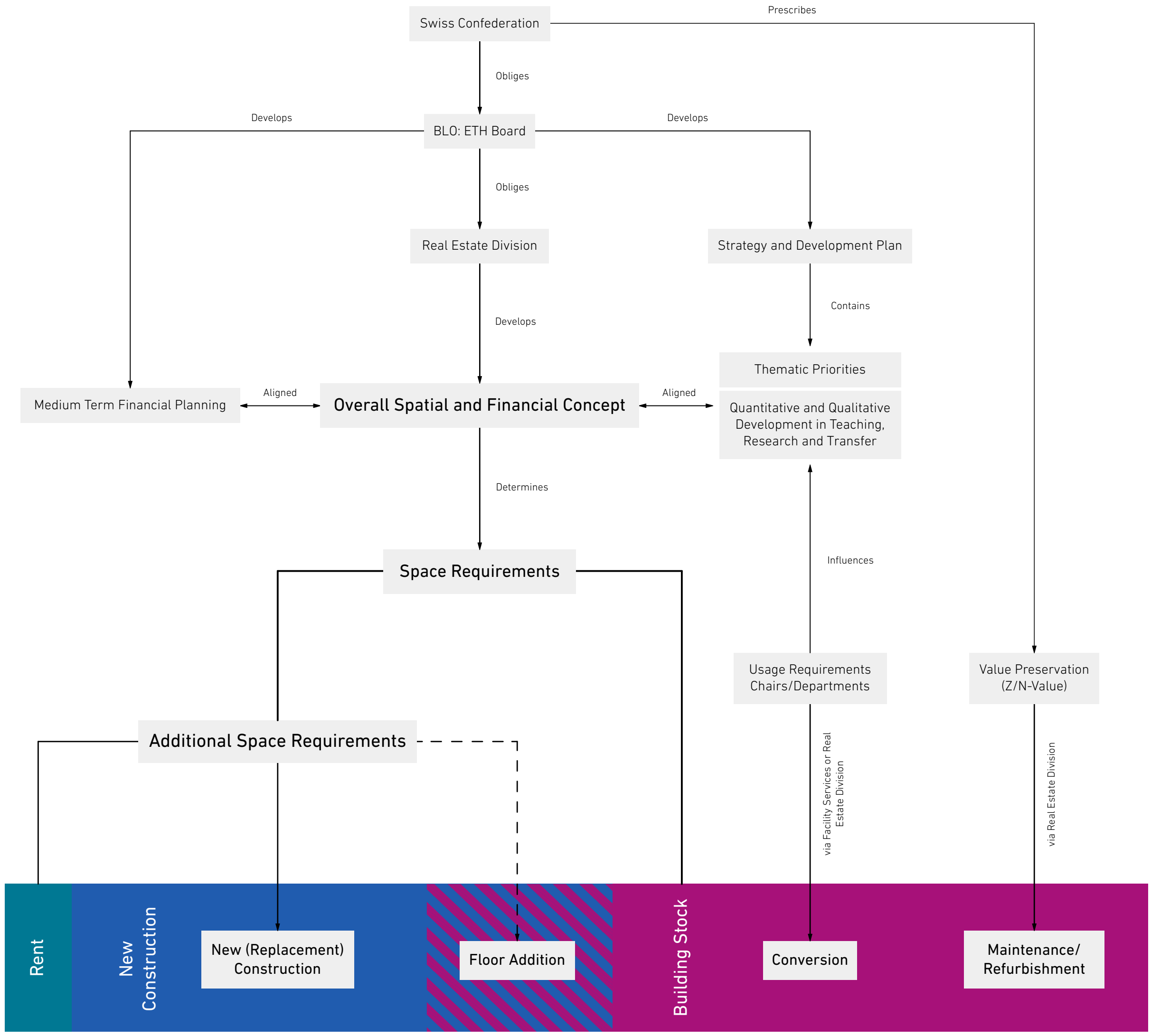


Fig. [2.1]: This diagram depicts the real estate development process of ETH Zurich in a simplified manner. it suggests that a systematic decoupling regarding the treatment of the building stock and the provision of new space is apparent. Due to their different procedural natures, alternative strategies of meeting current and future needs, such as adding floors to existing buildings, are systematically neglected.

conclude that no potential is systematically sought in the existing building stock to create new space.

Procedural Approaches

ETH basically treats its buildings in three different ways, all of which function differently in terms of their procedural nature and have to overcome different bureaucratic hurdles. They include the maintenance/refurbishment of buildings, the partial conversion of rooms, infrastructures and parts of buildings, and the construction of new buildings, either as replacement buildings or on greenfield sites. The different procedural natures lead to a systematic decoupling of these three approaches with regard to the decision-makers and, consequently, the decision-making process. In short, ETHs approach towards the built environment is not a holistic one. Of course, the outstanding complexity of an institution like ETH has to be taken into account here, but there clearly is a potential for improvement at hand in this regard. The following paragraphs elaborate on the three approaches by ETH of dealing with its building stock.

Maintenance/Refurbishment

The building stock of the ETH is assessed with the help of the Stratus tool, a planning software that uses financial, structural and energy data to enable the value retention and development of real estate portfolios over their entire life cycle. Different building components with different lifetimes are distinguished. Based on this assessment, calculations are made as to when the renovation of a building is worthwhile. In doing so, ETH Real Estate is guided by the Zustands- zu Neuwert (condition-to-use value), which in average must not fall below 0.8 for the entire portfolio. This value is determined by the Swiss federal government, who own both the buildings and the land, and provide them to ETH under specific conditions. The choice wether to leave a building as it is or to repair/renovate it appears to primarily depend on this Zustands- zu Neuwert.

Conversion
Conversions are mainly initiated by the professorships and departments and are assessed and carried out by the Real Estate Department (Abteilung Immobilien). For conversions < 20,000 CHF Facility Services are responsible. Most of these are minor local interventions, often of a technical nature, which can be very expensive due to the technical systems implemented. For example new connections, air inlets and outlets, etc. These smaller renovations of less than 3 million Swiss francs make up the majority of ETH Real Estate projects (over 90%).

New Construction
New construction is ETH's standard response to a need for additional space. Due to the very long planning horizon, new areas are even planned open to use, i.e. it is often really only a matter of creating new HNF (Hauptnutzfläche) that will only be occupied with specific uses later in the planning phase.

Top-Up
As early as 2021, in an internal meeting on the further building development of ETHZ, Urs Weidmann, the vice president for infrastructure, said, "Simple densification potentials have been exhausted" and with regard to upcoming renovations, "The buildings that are being renovated are state of the art. But they are simply not space expansions." While this is surely a simplified statement for the sake of a presentation, the possibility of creating additional space on existing buildings is obvious, especially in the case of an unavoidable renovation of the existing buildings. In other words, by using the static reserves of an existing building, more space can be created on the footprint of a building without demolishing it. Thereby, the grey energy can be preserved in the existing building, there are no construction emissions, there are no demolition emissions, just to name a few ecological advantages of adding storeys. Not to mention other negative externalities that an addition can avoid when compared to a (replacement) new building.

In the spirit of Ulrich Weidmann's statements the procedural decision as to whether a building is to be renovated, refurbished and topped up, or a new replacement building is to be constructed is largely not regulated within the existing guidelines. As mentioned before, the procedural provision of new space seems to be systematically decoupled from the management of the existing building stock. The sustainability guidelines, for example, only come into play when the decision on what to do with a building has already been made. In conversation with ETH Real Estate, it emerged that the fundamental decision on how to deal with a building is often made with a team of external specialists and the ETH Board and does not follow any specified procedure or guideline. This procedural openness certainly has advantages. It will certainly give decision-makers more freedom and room for interpretation. But it unfortunately also leads to sustainability concerns not being treated as holistically as they should.

Whilst the construction of floor additions has been carried out in more and more cases over the last years, adding floors to existing buildings is still not seen as a general solution and potential in the wake of an increased space demand in the future. This overlooked strategy is not being thoroughly thought through and is not being developed further.

Whether or not floor additions are actually (ecologically) more sustainable will be examined in a later section of this chapter.

«Simple densification potentials have been exhausted. The buildings that are being renovated are state of the art. But they are simply not space expansions.» ~ Ulrich Weidmann

Fig. [2.2]: The HPM building on Campus Hönggerberg is one example for current development within the existing building stock. An additioan including a top-up was planned by Fischer Architekten and finalized in 2018.

Sustainability Guidelines

As part of ETH's real estate strategy, sustainability regulations have been implemented since 2021. Apart from certain overarching target values or standards, the „Richtlinie Nachhaltigkeit" is used as a guideline to define project-specific sustainability goals It states: „The guideline is to be applied to all ETH Zurich construction projects with the aim of promoting a comprehensive way of thinking that is indispensable for sustainable construction and paving the way for the realisation of sustainable buildings."

Based on a building parameter matrix, a target agreement is first made by the project management, who is part of the ETH Real Estate Division (Abteilung Immobilien) from which the building standards to be fulfilled are then derived. For projects with a construction budget of over 0.5 million CHF, at least the Checklist for Sustainable Construction (Checkliste für Nachhaltiges Bauen) is to be applied, which was drawn up by the ETH itself. Above construction costs of 3 million, a target agreement in accordance with the Swiss Society of Engineers and Architect's SIA 112/1 norm is obligatory. Thus, many projects are filtered out, so that only about 1/6 of all ETH real estate projects are subject to a target agreement, and an even significantly smaller portion is subject to a complete target agreement according to SIA 112/1. The SIA 112/1 standard forms a template for many sustainability instruments. According to SIA, the target agreement is defined as „a Process of definition and binding agreement of targets between client and planner, with which building construction projects can be promoted in the context of planning and realisation with regard to sustainable building. Within the framework of the agreement on objectives, the client and the planner select those criteria that are relevant to the concrete project and regulate the cooperation on an object-specific basis". [2.3] The possibility of selecting criteria makes the sustainability guideline appear more binding than it truly is. The sustainability standards derived from the target agreement must also often only be partially fulfilled. In competition descriptions, for example, a certain degree of fulfillment is often targeted, rather than its complete implementation. All in all, the handling of sustainability issues seems to be very unregulated, not binding and more qualitative than quantitative. Furthermore, the control of whether the guideline has been respected is carried out by the same authority that applies it, the Real Estate Management Department (Abteilung Immobilien). Thus, the checks and balances that such a matter deserves are not given. The fact that the guidelines are only applied after the decision for a concrete project strategy stands in the same sense.

The following chapter examines whether topping-up is really the best option in terms of sustainability compared to other development strategies.

Real Estate Development Strategies in Comparison

"If it can't be reduced, reused, repaired, rebuilt, refurbished, recycled or composted, then it should be restricted, redesigned or removed from production“
~ Pete Seeger

Normative Development Strategies

In assessing different normative strategies of real estate development, considering not only operational energy demands, but also grey energy investemtns of construction, is crucial. This allows for a complete comparison of various approaches.

ETH's building portfolio is in need of a significant development in the upcoming decades, in order to meet the 2050 sustainability goals, as well as satisfy the spatial needs of the institution. The currently existing building stock plays a crucial role in this development. Only by strategically developing the building stock and preparing it for the future, these targets can be reached.

Different normative development strategies are at disposal and can potentially play a role in the process of generating sufficient useable area. In the following, possible strategies are briefly explained and put into context of ETH's current real estate strategy.

Continuation without Intervention
A first attitude towards the building stock is the complete dismissal of constructive interventions. No significant refurbishments are carried out as part of this strategy. Maintenance work is executed, as far as it is necessary to preserve the current value of the buildings at a consistent level.
In ETH's current real estate strategy, this path only plays a limited role. For all buildings without up-to-date energy efficiency levels, which are not foreseen for demolition, refurbishment works are scheduled in the upcoming decades. This can be partly explained by the Swiss legal regulations on building energy use, which introduced new limit values in 2023. The regulation is illustrated in Fig. [2.3]. The building stock is in need of according renovation, in order to remain within the legal framework in the upcoming decades.

Minor Energetic Refurbishment
The option of carrying out minor renovation works, in order to meet legal standards with existing buildings, is a resourceful and effective measure to reduce heating energy demands. The constructive measures are dimensioned according to the minimum legal requirements. Generally, a refurbishment of the building envelope is combined with a replacement of carbon-intensive heating systems by a renewable solution.
The current real estate strategy foresees a large number of stock buildings for energetic refurbishment. Such interventions are in most cases tied to scheduled maintenance works according to Stratus. The exact target values will only be defined in competition briefs and may refer to minimum legal standards. In this sense, minor refurbishment currently plays a significant role.

Major Energetic Refurbishment
The option of carrying out major renovation works on stock buildings contains similar measures as the minor counterpart. The renovation targets are though set higher and aim at reaching highest standards in energy performance and quality of the envelope. The post renovation performance of the building systems can be compared to newly constructed buildings. These standards potentially exceed Switzerland's legal regulations.
As mentioned above, the current real estate strategy foresees a large number of stock buildings for energetic refurbishment. According to the sustainability guidelines, alternative standards can be defined in the target agreement, such as SNBS or Minergie. [2.5]
The appropriate labels to consider are defined by the guideline according to construction cost, though no definitive targets are generally set. The definition of exact target values or standards is only to be carried out in the early planning phase or in competition briefs. In this sense, major refurbishment potentially plays a significant role.

Refurbishment and Floor Addition
Combining a major energetic refurbishment of stock buildings with a floor addition is another strategy of utilizing the exiting building stock. In the following, the refurbishment standards and results of a major intervention will be considered for this case. The degree of addition must be chosen in relation to potentials

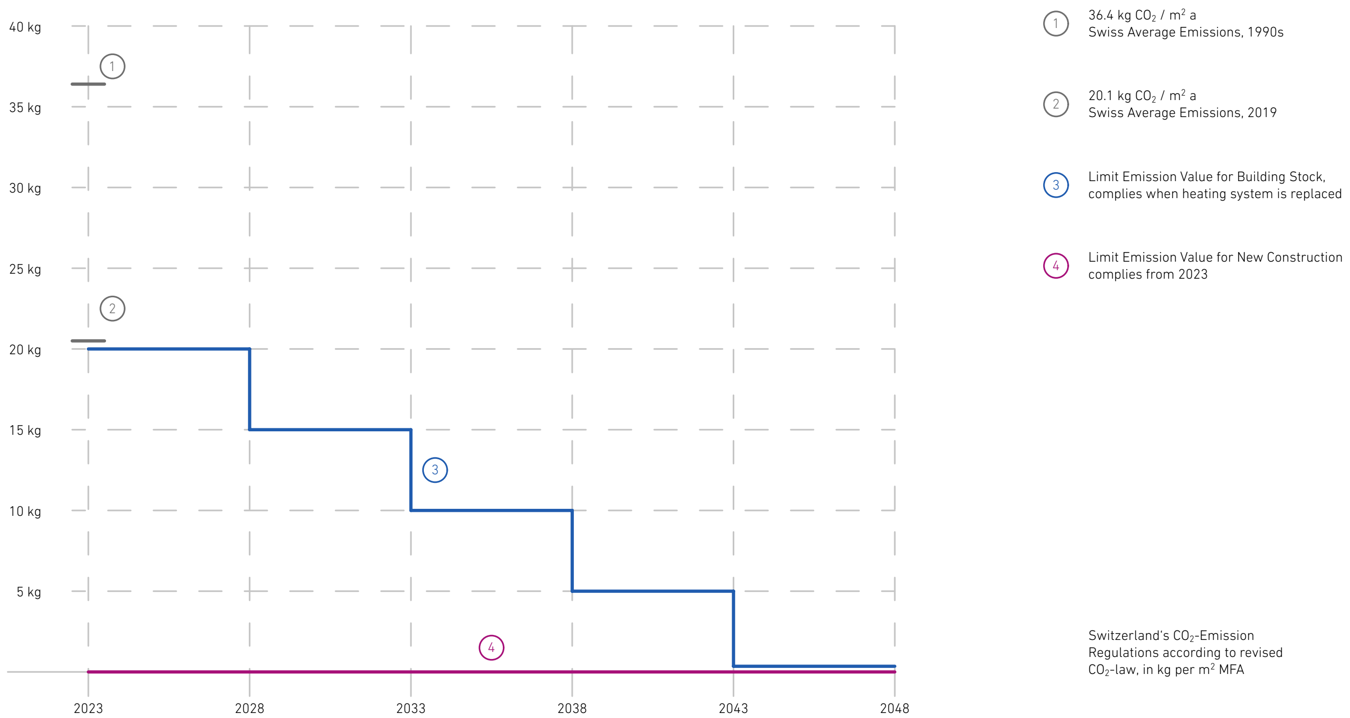


Fig. [2.3]: As part of the revision of Switzerland's CO_2-law, limit values uf carbon emission of heating systems have been introduced. The regulation applies to all new construction or replacement of heating systems in existing buidlings. Starting in 2023, the limit values are foreseen to decrease in intervals of 5 years, in order to reach net-zero requirements before 2050. [2.4]

of the building's existing structure. In the following, the construction of two additional stories will be considered in the model calculations.
The current real estate development only considers the strategy of floor addition in few exceptions.

Replacement Construction
The demolition of stock buildings in favor of constructing a replacement building, often allowing for greater utilization of the land, is another strategy of real estate development. This option does not make use of the potential of the existing built structure and leads to significant waste of grey energy stored within. After a complete removal of the existing building mass, the newly developed construction can be planned efficiently and according to the highest energetic standards.
The significant energetic effort of re-constructing the building fully needs to be taken into account, as it contains substantial grey energy emissions.
The strategy of replacement construction is foreseen in ETH's real estate planning for a number of buildings. In most cases, a significant increase of the useable floor area goes along with the replacement. Due to the general aim of constantly increasing the availability of floor area, this strategy is usually only opted for in cases of a significant increase of the utilization rate.

New Construction on Undeveloped Land
The last normative development strategy is the planning and construction of new buildings on priorly undeveloped land. This option gives the highest freedom in planning and allows for the construction of buildings, reaching highest efficiency standards. As this strategy does not relate to the building stock, no existing potentials can be made use of. Apart from grey energy investments for the building's construction, also other externalities need to be taken into account, such as increasing land use and decreasing density. These and other external effects will be addressed in more detail in a later section.
The construction of new buildings plays a central role in ETH's current planning of the real estate portfolio. Large amounts of floor area are foreseen to be constructed in this way in the upcoming decades. Particularly on campus Hönggerberg, significant ranges of undeveloped land within the ring road perimeter will be overbuilt in this manner.

Comparison of Energy Balances

The following comparison of the different development strategies is based on scientific data, gathered by the University of Wuppertal. [2.6] The study aims at giving a representative overview on the energy balances and carbon emissions of construction, refurbishment, building operation and eventual demolition, applied in the different development scenarios. The content of said study is not fully represented in this report chapter, but selectively condensed according to the specific case of ETH's real estate portfolio and the corresponding dates and scenarios of building development.

Assumed Values
In order to generate broadly applicable statements and comparative values, a series of normative assumptions was made, which will be explained in the following.

Stock Building and Construction
The modeling of the energy balance was based on standard values for typical buildings in massive construction, built between 1950 and 1970 and featuring a low quality building envelope. No significant differences were found between buildings from 1950 or 1970, as the construction methods and insulation quality were generally of similar quality. The emissions caused by possible demolitions were calculated for these typical construction methods, made up of 92 to 97% of mineral materials, 3 to 7% of metals and a maximum of 3% of other materials, such as polymers, glass or timber.

Heat Load and Heat Energy Demand
Different heating systems with respective heat energy demands were considered in the comparison. For the stock building prior to refurbishment, featuring a low quality building envelope, a Heat Load of 125 W/m^2 and a respective Space Heating Demand of 1314 kWh/m^2a were considered. A value of 2300 Peak Load Hours was assumed in this calculation. A reduction of these values to 80 W/m^2 and 184 kWh/m^2a for a minor energetic refurbishment, as well as to 45 W/m^2 and 104 kWh/m^2a for a major energetic refurbishment was taken into account. For the new construction, values of 10 W/m^2 and 23 kWh/m^2a were considered.

Heating System Efficiency
The comparison was developed, considering two types of heating systems. One one hand the gas heating of the stock buildings with a system efficiency of 0,9. On the other hand a heat pump, performing with a system efficiency of 3,9.

Primary Energy Factor
The Primary Energy Factor was used to include the emission-intensity of the different energy sources, also considering emissions caused by production and distribution. For gas heating systems, a standard factor of 1,1 was taken into account. For the scenarios, using a heating pump, a current standard value of 1,8 was considered. As a gradual decarbonization of the Swiss electricity supply can be expected in the upcoming decades, this value was gradually adapted, reaching values of 0,4 in 2035 and 0,1 in 2050. A wide-ranging decarbonization of the energy production can be expected by 2050 through the expansion of renewable sources.

Fig. [2.4]: Replacement construction as a development strategy promises an advantageous energetic performance due to the minimized operational energy demands. However, the large grey energy efforts during construction are weighty negative influences.

Projected Lifecycle
In the modeling, a stock building with an age of 50 years is considered. The general energy balance is calculated for a further operational lifetime of 50 years. In the following discussion, the results of the comparison are though also projected into the further future, considering a possible lifetime of over 100 years.

To stay within the framework of ETH's real estate stock, an average building with 10'000 m^2 of useable floor area was used for the calculations. A projection of the building's energy demand without any intervention was carried out as a comparable base value. The minor and major refurbishment strategies were applied according to the assumptions described above. The demolition and replacement of certain building parts (e.g. building envelope, technical systems) was taken into account by factoring the demolition and processing of waste materials (minor intervention: 4.0 MJ/m^2; major intervention: 6.5 MJ/m^2) and new construction materials (minor intervention: 520 MJ/m^2; major intervention: 790 MJ/m^2).

For the fully reconstructed building, no increase of the useable area was taken into account for reasons of comparability. Again, the energy expenses of demolition and construction activity were taken into account. Standard values for demolition and waste disposal (0.65 GJ/m^2), as well as construction materials (13 GJ/m^2) were used. The values were chosen in a range of magnitude, representing low-energy buildings of today's standards.

The magnitudes of these numbers, up to 100 times smaller for the demolition investments or 25 times smaller for construction materials in refurbishment works than in new construction, already illustrate the substantial head start of retrofitted buildings in the energy balance comparison. This is well apparent in

Fig. [2.5], showing the overall energy balances.

The energy balance for a majorly refurbished building with a floor addition was calculated as a combination of the values of a major refurbishment and a new construction. An addition, resulting in an increase of 50% of the original floor area was taken into account (e.g. two story addition to 4 story stock building). The post-renovation heating energy demand was determined as a weighted average.

Findings of the Comparison
The results of the energy balance modeling, best apparent in the cumulated energy balance in Fig. [2.5], allows to decisively judge the benefits of different development strategies according to rational parameters. The biggest impact on the energy balance performance of a specific strategy is always marked by the primary energy input during demolition and new construction. The energy, invested into a new and highly efficient building, marks a vigorous head start in energy spendings, which can't be made up for during the phase of operation. This can be explained by the fact, that the amounts of grey energy are in a much higher order of magnitude than the annual operational energy demands. This statement though needs to be put into perspective of the choice of the heating system, which resembles another important factor. All cases, in which the gas heating is retained as the heating source, perform severely worse than the counterparts with electrically powered heat pumps. Even with large investments into the building refurbishment, the energy spendings of a gas heating lead to an overhaul of the energy balance of the replacement building after 30 years of operation. A first conclusion of the model calculation is thus, that any investment into the building development should include the implementation of a renewable and efficient heating source.

A second conclusion must be the poor energy balance of the replacement construction. With a head start of roughly 38 GWh due to demolition and reconstruction efforts, the strategy immediately has a difficult stance. Even though the operational energy spendings are well optimized and contribute little further to the balance, this strategy has by far the worst energy balance of all cases, using heat pump heating systems. The exception, is naturally the continuation without any refurbishment intervention, which is outperformed after only 11 years.

The comparison of the two different strategies of refurbishment presents an overall performance, strongly suggesting the benefits of a major intervention. Whereas the demolition and material investments of the major refurbishment strategy make up an energy demand of 2.21 GWh as the starting point of the operational phase, the value for the minor equivalent of 1.45 GWh is only 35% smaller. The difference in ope-

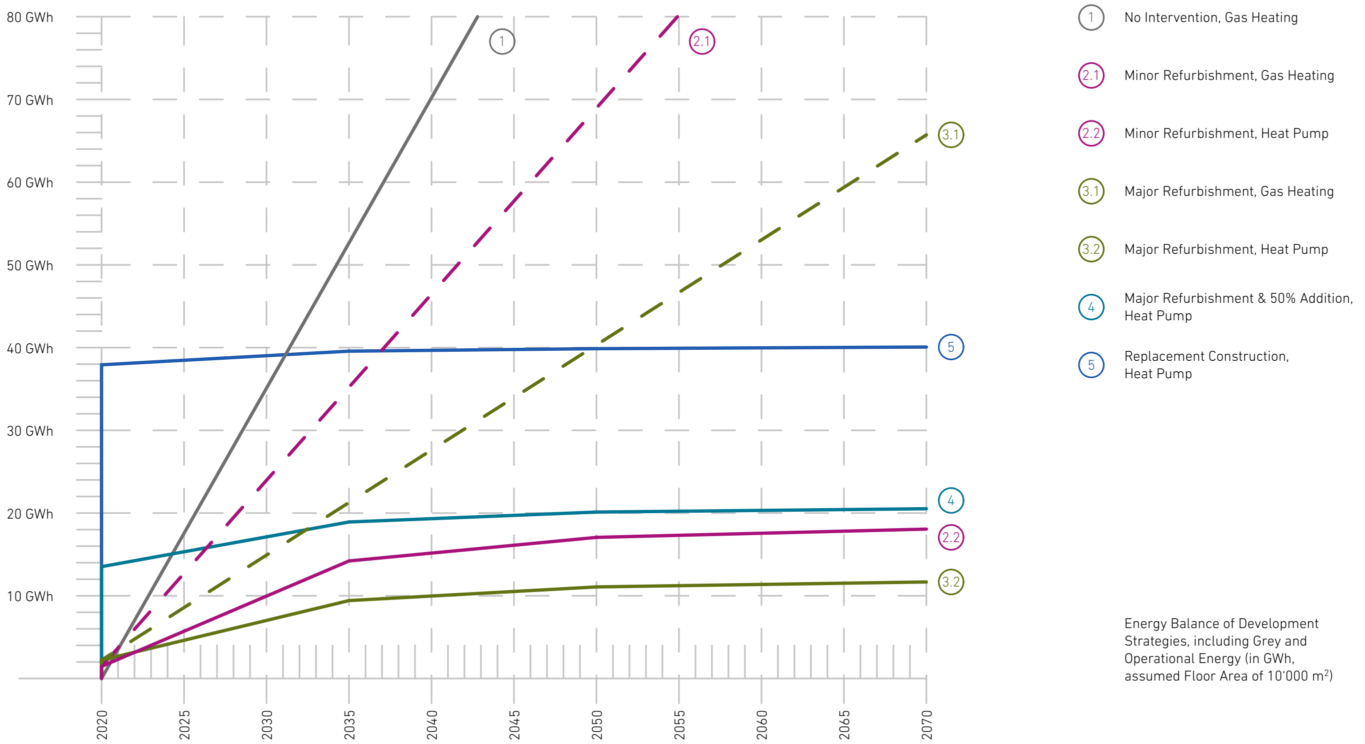


Fig. [2.5]: The comparative graph illustrates the overall energetic performance of different normative development strategies over a lifetime of 50 years. Most prominent is the interplay of efficient heating systems and resourceful constructional efforts. Considering the two factors allows for sustainable energy performance on the long term. The energetic benefits of development within the building stock is clearly apparent.

rational energy demands is much more significant and leads to the overhaul of the minimal head start after only 2 years. It becomes clear, what significant energetic benefits can result from a higher investment into a high quality refurbishment. This can not only be stated for the energy demand, but also the financial costs during the building's' lifetime. After 50 years of building operation, 6.39 GWh of energy spendings can be accounted for the major refurbishment. This is the approximate equivalent of 3'750 oil barrels' BTU.

The comparison considered a basic further lifetime of the buildings of 50 years after the construction intervention. This value can be questioned, as the projected lifespan of newly constructed buildings nowadays usually exceeds this duration. Especially regarding replacement construction, one is generally looking at longer timespans. As a gradual decarbonization of the electricity provision of Switzerland is assumed in the calculations, obliging operational energy demands derive on a long term. This allows to qualitatively judge the further energy performance, even if the lifespan of 50 years is outreached significantly. The lower operational energy demands of the replacement construction for instance, will not make up for the grey energy spendings during construction, even if a lifespan of multiple hundred years is assumed. Conclusively it can be stated, that replacement construction can not be legitimized energetically as a favorable development strategy.

Needs for Expansion

In the case of a needed expansion of ETH's useable floor area, the refurbishment of stock buildings can no longer be considered as the only favorable strategy, as no additional spaces can be provided. This leaves the comparison of new construction and floor additions to be interrogated. In order to conclusively compare the strategies, the ratio of majorly refurbished to newly constructed floor area needs to be evaluated. In the case of the floor addition, 1/3 of newly constructed floor area is coupled to 2/3 of refurbished building stock. As the smallest common value, the energy balance of three topped up buildings can be compared to the sum of two majorly refurbished structures and one newly constructed building (always under the assumption of 10'000 m² of useable floor area per building). The comparative calculation is illustrated in Fig. [2.6], presenting cumulated values for an estimated lifespan of 50 years after the intervention.

Although a slightly lower amount of energy needed can be accounted for the additive strategy, the difference is rather insignificant. The values of the overall energy balance for a lifetime of 50 years differ no more than an estimated 3%. This minor difference in

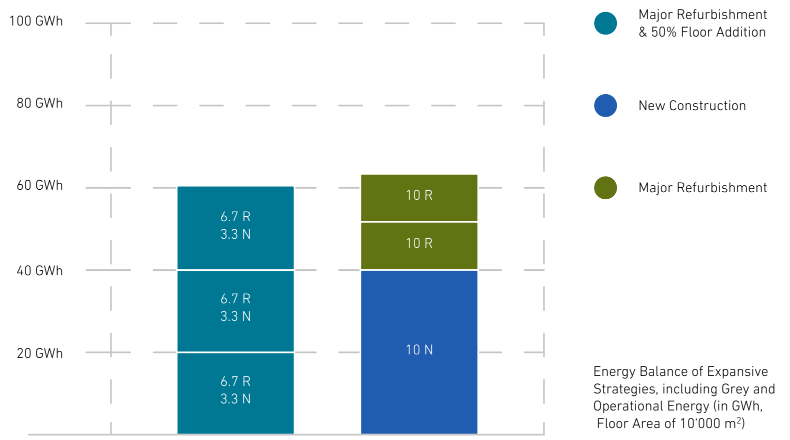


Fig. [2.6]: In the case of a needed spatial expansion, new construction and floor addition are two possible development strategies. When considering construction and operational energy demands over a lifetime of 50 years, savings of 3% can be accounted for floor additions.

energy demand may only be a small benefit, not sufficient in making additions within the existing building stock a favorable strategy. Advantages of a simplistic and holistic planning approach, as well as an optimized cost efficiency may speak for the construction on undeveloped land on the other hand. Whilst financial efficiency is still a significant factor in the real estate management of ETH today, it needs to be questioned, to what extent financial factors should be weighed up with questions of material use and ecology in the long term.

It is clear, that the opportunity for floor additions within ETH's building stock is limited and only allows for a certain spatial expansion. Not all buildings are structurally fit for such an intervention. Ultimately, the potentials need to be interrogated systematically, yet individually for every building of the portfolio. It can be expected, that for a portion of the portfolio, floor additions may be technically possible, yet coupled to significant constructive interventions within the existing structure. This may include the reinforcement of the structural elements or their partial replacement, possibly making extensive spatial or functional reorganizations necessary. Such interventions always need to be looked at critically and the additional energetic and material efforts need to be taken into account, when deciding over development strategies. Generally, floor additions are mostly just a legitimate strategy, when a sufficient structural reserve is present within the stock building. It can be expected, that such reserves are at hand in a portion of ETH's building stock. It is thus necessary to systematically locate these potentials.

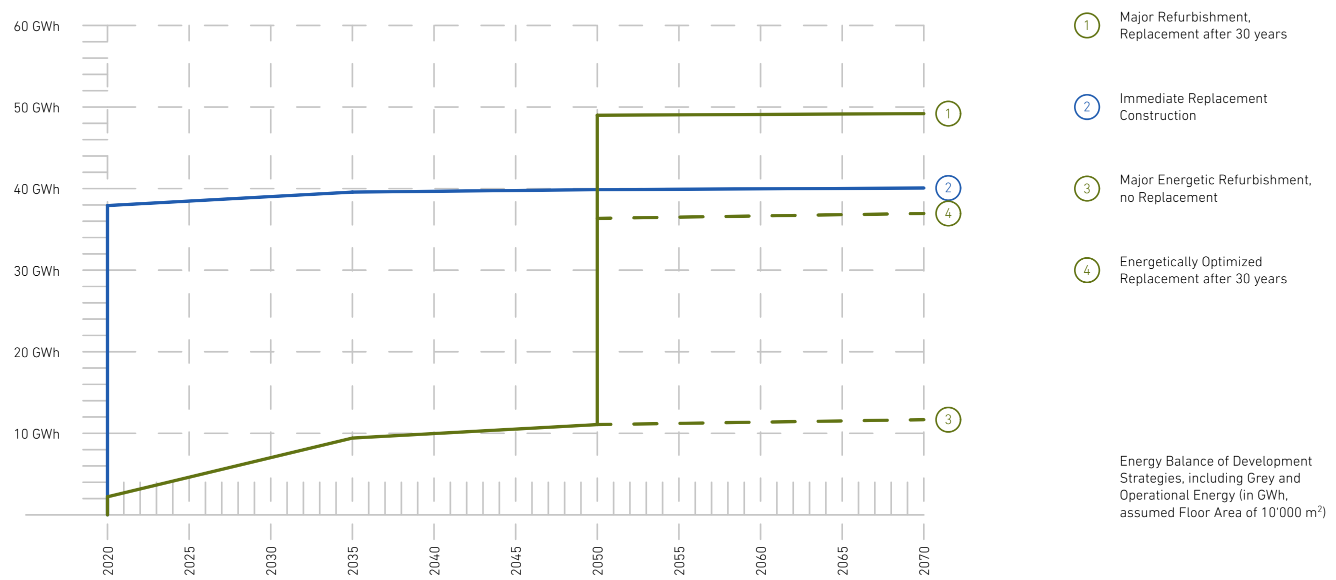


Fig. [2.7]: The projection of a lifecylce assessment of stock buildings onto the energy balance influences the energetic performance on the long term. The timing of potentially needed replacement of buildings or building elements, as well as technological advancements until that moment, are significant factors. Avaluating these factors is often speculative and predictions decrease in certainty, the larger the planning horizon is.

Lifecycles of Buildings and Elements

When interrogating the potentials of extending existing buildings with floor additions, the lifecycle of the existing structure and its elements needs to be taken into account. Fig. [2.7] illustrates the possible issues, that may emerge when neglecting projected lifecycles. The example shows the energy balances, projected over 50 years of two normative strategies - major energetic refurbishment, as well as replacement construction. In contrast to the previous comparisons, it is moreover assumed, that the refurbished stock building reaches the end of its lifecycle after 30 years of operation, making a replacement construction necessary in 2050. This second intervention accounts for an additional large investment in terms of grey energy of demolition and construction. Curve number 1 thus rises drastically, leading to a poorer energy balance, when compared to curve 2. In this model case, the immediate replacement construction would have to be prioritized over the ultimately delayed replacement construction. The advantageous energy balance of refurbishment, projected over a long lifetime, which is indicated by curve 3, looses its significance in consequence.

Already today, ETH makes use of the software Stratus, guiding its asset management and planning of maintenance or refurbishment works. By taking into account dynamic values of buildings and their individual elements, as well as gradual degradation, the lifecycle of buildings is interrogated at a high level of detail. The numerical valuation is also regularly complemented by on-site evaluations of the buildings' condition. On the basis of this information, the projection of the expected lifecycle for a building to be developed can be carried out. As the interrogation of a specific stock building, for instance in regard of structural reserves, is always a crucial and necessary aspect of strategy-finding, the evaluation of lifecycle-related issues should not be neglected.

Technological Advancement

When estimating on necessary future intervention, a high degree of predictive speculation is needed. No claim for correctness can be made, especially when it comes to timeframes of multiple decades. The further into the future interventions are projected, the less well-founded they are.

One important factor, playing into this issue is the question of technological advancement. Especially when dealing with the technical field of architecture and engineering, as well as the question of energy demands, future predictions are difficult to make with a high level of certainty. Generally, it can though be expected, that technological advancements, aiming at decreasing material consumption and energy demands of construction, will be made in the construction sector. Already today, the debate on the climate crisis and sustainable future developments fuels research and innovation with this specific focus. It can thus be assumed, that construction activity will become less resource-intensive in the upcoming decades. In consequence, the projection of energy balances into the future gets subjected to a certain degree of uncertainty. Looking again at Fig. [2.7], curve 4 illustrates possible advantages of the delayed replacement of the building. In this specific case, the replacement construction is supposed to be optimized in terms of grey energy investment by 1/3. Some studies suggest even stronger improvements to take place in the upcoming decades. A research paper, commissioned by the Swiss Federal Office of Energy (BFE) and the Office for Building Construction of the city of Zurich (Amt für Hochbauten) [2.7] investigated the extent to which improvements can be expected in the most important building materials by 2050. For the 28 building materials studied, ecological performance assessments were predicted which, when applied to the life cycle assessment of a residential reference building, resulted in a reduction of CO_2 emissions during the construction phase by 55%.

«Scientific research suggests, that technological advancements in the upcoming decades will cut energy demands for construction by up to 55 percent by 2050. The timing of constructive interventions thus becomes crucial.»

Apart from emissions caused by construction, especially operational energy demands contribute significantly to the ecological performance of a building. Also when looking at this factor, the trend towards optimizing energy demands can be expected to continue in the upcoming decades. Also new legal regulations or incentives may instigate this further development. Optimization of the building envelope, energy-efficient heating systems or passive coverage of the heating demand will amongst others likely continue to reduce the active energy demand per m². Meanwhile, the influence of these improvements will be accompanied by a changing situation within the Swiss electricity net. The changing fraction of electricity sources by technology, as predicted by the Swiss Federal Office of Energy [2.8], is depicted in Fig. [2.8]. The continuous decarbonization of the electricity supply will in essence decrease the impact of energy use on the CO_2-emission balance of buildings. Nonetheless, an optimized energy use will keep decreasing the environmental impact of buildings, as even renewable energy will not be produced completely without energy or material efforts.

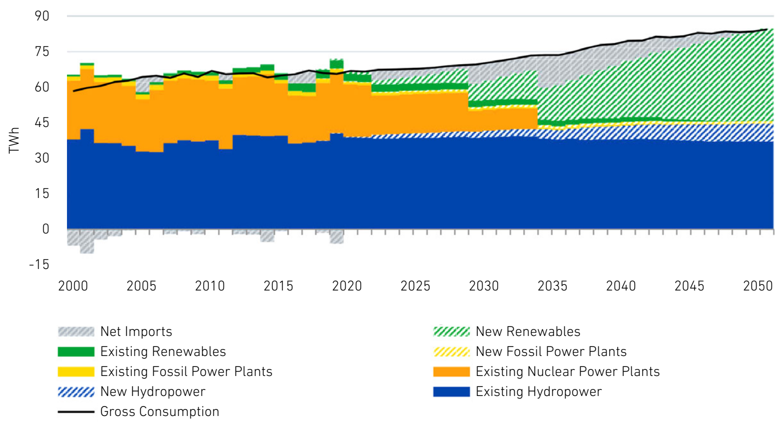


Fig. [2.8]: The continuous decarbonization of the electricity supply will in essence decrease the impact of energy use on the CO_2-emission balance of buildings. Nonetheless, an optimized energy use will keep decreasing the environmental impact of buildings.

In consideration of this it becomes apparent that the long-term energy balance of a building both for construction and operation is strongly linked to the development of energy provision, not only of the building industry in its own right, but of Switzerland as a whole. The long time horizon and the infinite number of influencing factors inevitably burden any prediction with substantial uncertainties.

In conclusion, the importance of considering the remaining lifecycle of existing buildings and their elements should be emphasized. Especially when the end of a building's lifespan is expected in the near future, assumptions with a comparably high degree of certainty can be made and the choice between replacement or refurbishment can be made on a better-founded basis. Ultimately, the question of utilizing exiting building structures or not is to be answered by careful analyses of the individual buildings in ETH's portfolio.

Surplus of Compactness

A further factor of the discussion on normative development strategies is the issue of buildings' compactness. This term is defined as the geometric relation between a three dimensional body's surface area and its volume. Regarding buildings, the term describes the relative amount of building envelope, needed to enclose a certain volume, respectively a certain amount of useable floor area.

The building envelope is a key element to address environmental concerns, as it is responsible for thermal transfers to the outdoors, causing energy demand and carbon emissions. [2.9] It is also amongst the most material- and emission-intensive building elements, thus contributing significantly to the overall grey energy of a building.

In refurbishment interventions, the building envelope is a main element of interest. As it is decisive of a building's heat transfer coefficient and thus of crucial importance in terms of operational energy demands, envelopes are often replaced during major refurbishment works. Also in replacement or new construction, the building envelope is an element of significant interest, as it plays a primary role in the creation of energetically efficient structures. In both cases, the realization of the building envelope is not only significant in terms of material use and carbon emissions, but also financially. The building facade, as a constructively complex element, is accounted for as one of the most costly factors during construction.

The advantages of floor additions in this regard, as illustrated in Fig. [2.9], are thus an attractive benefit of adding onto the existing building stock. The scheme shows the amount of surface area, that can be saved, when favoring a floor addition over a new construction on open land. The benefit of combing the construction of new useable area with the refurbishment of a stock building in the form of an addition lies in the possibility to insulate the two volumes „with each other". By adding a fully insulated addition onto the stock building, the need for roof insulation is omitted. Respectively, the addition looses the need for underground insulation, being placed onto a heated volume. In the case of cubical buildings, the needed surface area is reduced by two times the building footprint. Depending on the specific shape of the volume, this can account for significant savings. When using the example of a floor addition of 50% to a four story building, generating a final useable floor area of 10'000 square meters, the envelope surface area can be diminished by 3'300 m2. This value is equal to the total floor area, constructed in the whole addition.

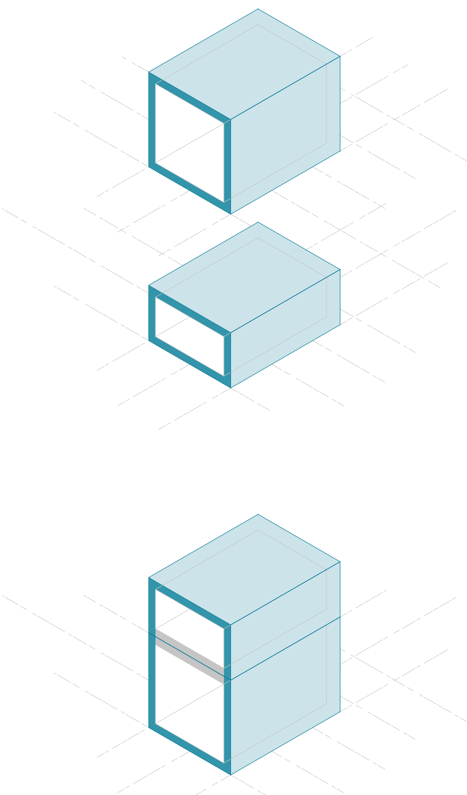


Fig. [2.9]: The schematic comparison of floor addition and new construction in terms of compactness and surface area of the building envelope illustrates the advantages of additive strategies.

Also regarding the use of operational energy, the advantages of an increased compactness is suggested by research. A 2020 study investigating various building densities and forms in terms of their annual heating energy demand found that increasing a four-story building by 50% through a floor addition would reduce the heating energy demand per m^2 of useable floor area by almost 3%. [2.10] Although this improvement may seem insignificant at first glance, it can make a substantial difference over the lifespan of a building. Therefore the significance of compactness becomes apparent.

Influence of Volumetry

It is clear to say, that benefits or disadvantages of either floor additions or new construction in terms of compactness are always dependent on specific volumetric conditions of the architecture. In certain cases, the lack of optimality of a stock building's volumetric form may not allow for efficiently compact additions. In such cases, efficiently planned new construction with an optimal compactness factor may perform in a favorable manner. The possibility of an advantage in terms of material use, cost and carbon emissions should though always be taken into account and the different development strategies should be interrogated accordingly. A systematic consideration of this factor should be integrated into the decision-making process.

Externalities of Construction and Land Use

"The environment and the economy are really both two sides of the same coin. If we cannot sustain the environment, we cannot sustain ourselves."
~ Wangari Maathai

The analysis of the overall energy balances has shown, that the most sustainable strategies consistently make use of the energetic and material potential of existing structures. Whenever stock buildings are at hand and the opportunity of refurbishment can be taken, it should be prioritized over new or replacement construction. This can also be stated for floor additions in comparison to the new construction on undeveloped land.

When looking at the real estate strategy of ETH, it has though also to be considered, that growing numbers of students and employees constantly increase the demand for space. This paradigm of growing spatial demands has to be looked at critically. Also opportunities of internal densification of use, allowing for a decreasing spatial demand, may be checked systematically. Major potentials to be activated can be expected in this regard, which in consequence would lead to a reduction of the overall demand for construction.

This topic will be covered extensively in the chapter on the Future for Rooms. Anyway it can be assumed, that not all spatial demands can be satisfied within the existing building stock and a diminished need for construction will remain. The comparison of energy performance has already proven a benefit of realizing such demands as floor additions within the existing building stock, likely combined with the refurbishment of the stock building. The higher complexity of planning within the existing, more complicated regulations or permission processes and possibly higher costs per realized area are potential factors against this development strategy, favoring new construction on previously unoccupied land. Furthermore, the current development strategy of ETH relies heavily on the construction of new buildings, in order to maintain a Z/N value of 0.8 or higher. It should be questioned, whether this benchmark is a well chosen guiding value, when sustainable development within the existing stock is sought after.

The term 'externalities' refers to unintended social, economic or environmental consequences of an activity (i.e. building construction), that go beyond affecting the parties immediately involved. It is highly important to take such effects into account in project evaluation and planning.

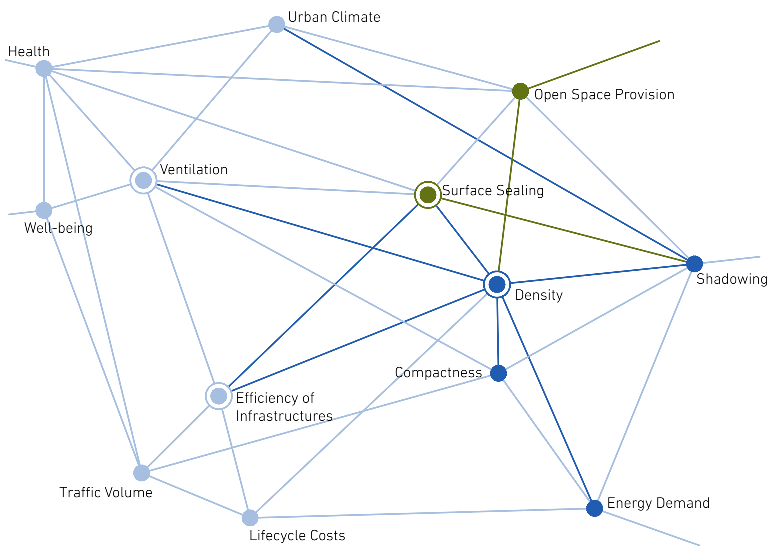


Fig. [2.10]: Many externalities of planning and construction are highly interrelated, hard to grasp and form a complex network. These interdependencies of various factors make sustainable planning especially complicated. The consideration of ecological, economical and social interrelations, as a complementation to energy performance assessment, is an important factor of sustainable spatial planning.

In the case of ETH, a strong focus on expanding the building portfolio with new buildings on the perimeter of the Hönggerberg campus can be observed. In the following, this strategy will be interrogated critically and opposed by further externalities of construction activity and land use.

Benefits of Sustainable Planning

While factors like construction cost, energy performance or efficiency of planning can all be captured numerically and compared very easily, many other factors of urban planning and architecture can't be. The various externalities of construction activity and land use are thus often overlooked. Especially when it comes to issues of conserving biodiversity, ensuring social equity, or enhancing the quality of life, the benefit of sustainable planning can often hardly be measured or expressed quantitatively - even though it might be highly impactful. [2.11] Many of such topics are often highly interrelated, hard to grasp and form a complex network of external effects. The interdependencies of various factors make sustainable planning especially complicated, as Fig. [2.10] indicates. For example, the creation of high density and urban compactness may have positive effects on the efficiency of energy systems and infrastructure provision, whilst it may negatively affect the availability of open space, enhance urban heating effects or increase the likeliness of rainwater flooding.

Nevertheless, there is a strong impetus to actively integrate sustainability factors into planning practice. Benefits of sustainable urban planning can be categorized in three levels - ecological profits, profits for humans and society, as well as economical profits. Ultimately the reason to act as sustainably as possible may not lie in the prospect of potential profits, but rather in the pressing need to move away from unsustainable, disruptive and ultimately highly destructive current practices.

In the following, a selection of topics of interest will be briefly discussed. No claim is made to completeness. Rather, it is intended to promote a general awareness of the sustainability factors, affected differently by various real estate strategies.

Land Use and Internal Densification

The utilization of areas not previously used for residential and infrastructural purposes is the physical expression of urbanization, sub- and de-urbanization. Land consumption is considered a significant environmental policy challenge and a so-called "persistent problem" in environmental policy. Land consumption has numerous negative effects, primarily resulting in the loss or impairment of ground-based environmental functions. [2.12] The most intensively discussed effects of land consumption include the ongoing loss of high-quality agricultural land, the reduction of biological diversity, the development of car-dependent urban structures and increased traffic, as well as the generation of consequential costs for the construction and operation of technical infrastructure facilities.

Fig. [2.11]: The urban planning of construction ground and green space is a constant negotiation over ecological factors. Though often difficult to quantitatively measure, effects of environmentally sustainable planning are broad and evident. Photo: Erlenmatt park in Basel.

One of the most important approaches to reduce land consumption in urban development is known as "internal urban redevelopment." In urban planning practice, this term generally refers to three types of measures: closing gaps in areas within continuously built-up neighborhoods; land recycling, which involves the conversion and reuse of abandoned urban areas; and densification, which aims to expand or complement the building use of properties through new construction, expansion, or renovation of buildings. In addition to primarily quantitative aspects, internal urban redevelopment also has a qualitative dimension. Internal urban redevelopment measures can contribute to improving inner-city green space situations and optimizing the urban building stock. Against this background, the concept of "double internal redevelopment" [2.13] was created, which aims to protect open landscape areas from further construction interventions while simultaneously enhancing the existing urban space through measures that mobilize and enhance green space. [2.14]

The development of ETH's building portfolio through strategies that actively use potentials of the existing building stock, allows to respect the before mentioned issue of land use and densification. It can thus be concluded, that internal development, favorably in the sense of coupling needs of refurbishment with additive interventions, is to be prioritized strongly in regard of sustainable land use. Not only are some core functions of the natural surrounding retained by avoiding new construction on undeveloped land, but the strategy also provides the opportunity of optimizing the existing building stock and its adjacent open spaces.

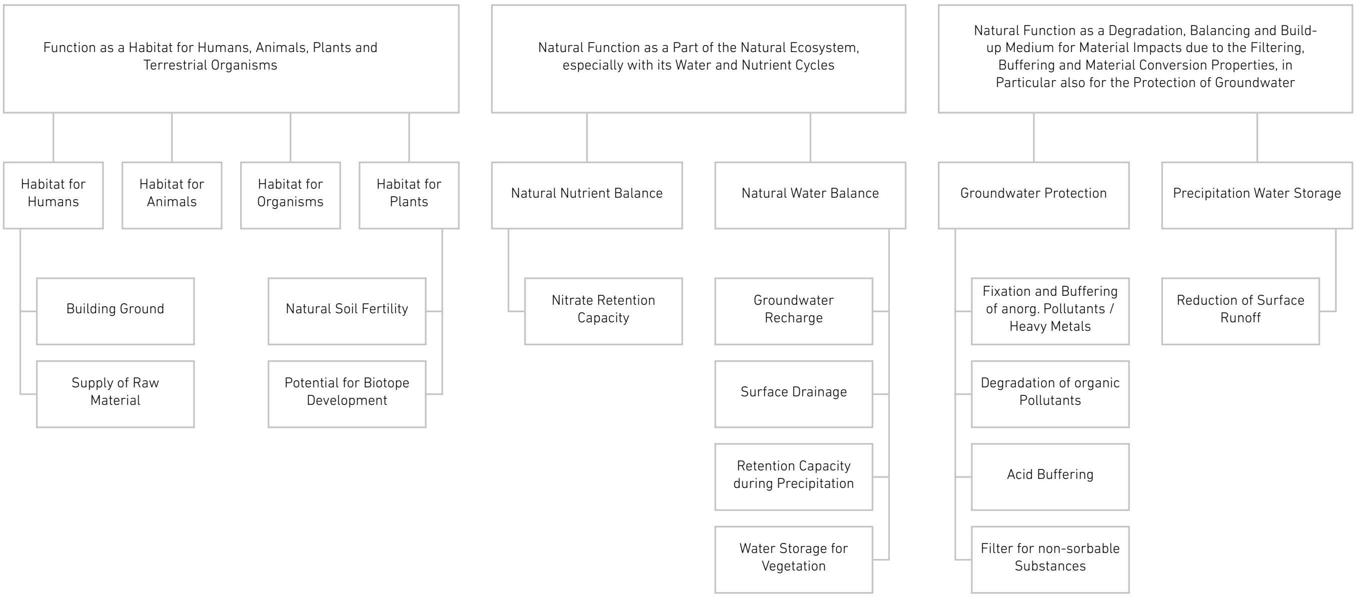


Fig. [2.12]: When land is overbuilt, diverse natural functions of fertile soil and water systems are lost. The hierarchical diagram emphasizes the variety of functions, the natural environment is capable of providing - from biodiversity to the reduction of pollution in groundwater and air. When natural ground is used as buidling ground, these natural functions are often irreversibly lost.

Preservation of Soil and Water
The quality of soil and the availability of water are central prerequisites for the human inhabitation of the landscape. Their existence is the result of interactions between the water cycle and soils within a global cycle of water - without water, there is no soil, and without soil, there is no water. Unlike other resources, that would be represented in a degenerative material flow, water is not consumed, but is in a continuous cycle driven by solar radiation. Liquid water constantly evaporates, forming clouds in the atmosphere, and their water reserves return to the earth in the form of precipitation, creating both surface waters and groundwater. Flowing water, through continuous erosion, shapes soils and topography and at the same time, these elements influence the appearance of bodies of water through numerous factors.

Water systems and soils serve diverse natural functions as a basis for life for humans, animals, plants, and soil organisms, as depicted in Fig. [2.12]. Bodies of water are the foundation for human drinking water, industrial process water, and agricultural irrigation water. Simultaneously, they play vital roles in fishery, transportation of goods, recreation, biodiversity, and contribute significantly to the removal of pollutants through their biological self-purification. In addition to water ecosystems, soils represent an important habitat for flora and fauna, serving as the basis for agriculture and forestry, as well as a foundation for urban development. They act like a sponge, storing rainwater in their pores, reducing surface runoff, and thus decreasing river flooding events. The stored water is made available to vegetation - without these water reserves stored in the soil, there would be no green, productive landscapes. At the same time, soils can absorb dissolved pollutants and nutrients in water, bind them to soil particles, and remove them through chemical transformations. This generally results in clean groundwater, suitable for drinking water production. [2.15]

The higher the economic value of land is as building ground, the more pressing the question becomes of how much space should be allocated to natural systems of water and soil. As the natural regeneration of soils is a very slow and limited process, natural land can be assumed to be a finite resource. This makes the protection of land and water a crucial factor of sustainable urban development strategies. When considering the issues of gradual occupation and surface sealing of natural land through construction activity, new construction on undeveloped land is clearly the least favorable normative strategy. While this option diminishes the availability of natural water and soil functions, all other normative strategies can be rated equally. Both refurbishment, floor addition and replacement construction do not lead to an increased occupation of land, whilst potentially allowing for a positive enhancement or mobilization of green spaces as part of the planning intervention (i.e. „double internal redevelopment").

Agricultural, Recreational and Climatic Functions
The occupation of undeveloped land through its use as building ground does not only diminish natural systems of soil, water, wildlife or biodiversity, but potentially also leads to the displacement of alternative land uses with a wide range of benefits. This may include the provision of agricultural land, recreational or lei-

Fig. [2.13]: The conversion of prime agricultural lands to nonagricultural uses is a main topic of concern. Highly productive soil, which has taken centuries to form, is irreversibly removed. Such conversions are often legitimized by the higher economical value of building grounds.

surely functions, as well as the mitigation of urban heating effects. The effects of such conversions are disadvantageous in various regards, whilst they may often follow the path of highest economical returns or optimized land value. Necessarily accompanied by an act of rezoning, the conversion of green agricultural or recreational land to building ground holds the opportunity for significant financial profits. However, this quantitative validation barely takes less-profitable, yet vital functions into account altogether.

The conversion of prime agricultural lands to nonagricultural uses, such as infrastructure or building ground, is a main topic of concern. Although it may result in higher economical return in the short term, it can also irreversibly remove highly productive agricultural soils that have taken centuries to form. In numerous regions, the use of agricultural land is of great importance to local communities, both as a provider for an agrarian economy, as well as in forming locally characteristic identities. The increasing interest in retaining agricultural land in metropolitan areas stems in part from a growing movement for food security, access to locally sourced produce or urban agriculture. In the current condition, especially small farms at the city's edge play a crucial role in fulfilling these functions. [2.16]

On the other hand, unbuilt open land within the city or in its proximity also fulfills the purpose of recreational space for the citizens. The availability of green environments is a significant factor in achieving high physical and mental well-being within society. Contact with nature, active recreational opportunities or an urban environment, that encourages physical activity, all contribute to this quality. Access to trees, wildlife and green spaces, especially when well managed and safe, promotes well-being, social interaction and social cohesion. People with access to nearby nature are generally healthier than those without, as contact with nature impacts positively on various physical and mental health factors. The benefits of nature and green space for well-being come at three levels - viewing nature, experiencing nature and being active in nature - all of which can directly or indirectly be sustained by retaining a high degree of accessible green environments in or around the city. [2.17]

Finally, green natural environments have a significantly positive impact on various aspects of the urban microclimate. Poor air quality and urban heat are considered to be some of the most significant environmental health risks in rich countries and are immediately affected by the condition of the urban environment. Whilst traffic, industrial activity, transport and buildings' emissions contribute to these effects, green environments hold the capacity to significantly mitigate them. Urban vegetation acts to reduce various kinds of pollutants, such as ozone, heavy-metal particles or sulphuric oxides. Micro-organisms in the soil reduce the amount of carbon monoxide. While plant and tree species vary in their tolerance of pollution, there are valid reasons to promoting green environments within urbanized areas. [2.18]

The economical and sustainable management of land and green spaces is a central concern of sustainable urban planning. Planning dense city structures and the re-densification of existing structures play a pivotal role in this regard. In areas with high urban density, a particularly sensitive approach to inner-city open and green space planning is required. Even during densification, ecological functions must be considered and, whenever possible, preserved. An integrated and systematic consideration of green space planning and ecology is essential, not only to maintain existing undeveloped green spaces but also to ecologically enhance urban areas through precise development of the green surrounding. [2.19] Therefore, the strategy of "double internal redevelopment" mentioned should be pursued as effectively as possible.

Reflections and Suggestions on Process Reconfiguration

When reexamining the analysis of ETH's real estate development processes in the first part of this chapter, we can draw new conclusions based on the various findings presented in the comparison of potential strategies. This allows for suggestions to be made on possibly advantageous reconfigurations of the procedural structure. In the following conclusion, these main reflections will be discussed.

Utilizing Existing Potentials

The lack of systematically approaching the building stock and need for construction holistically has been laid out. In ETH's current real estate management, existing buildings are mostly just dealt with through maintenance, whilst an effective investigation of potentials for development is not foreseen. However, it needs to be acknowledged, that addition or extension projects are not fully absent and have increasingly come up under the pressure of sustainability goals in the past years. Still, such energetically and environmentally advantageous approaches are not to be found integrally in any development guidelines. The tendency to develop the building portfolio through the construction of new buildings is further strengthened by the abstract planning of quantitative volumes and useable areas, rather than in specific projects.

«A more holistic planning approach would allow for more sustainable and efficient solutions to be found. The potentials of stock buildings should be exploited to the fullest through transformations, conversions or floor additions.»

With the present urgency of finding sustainable solutions to develop ETH's building stock of the future, additive construction strategies and the utilization of structural potentials of the current building stock would necessarily need to become a valid part of the planning processes. Including the investigation of the current building stock systematically in the management processes of ETH real estate would thus be a desirable alteration. Such investigations may become tied to two possible moments of the planning process: the occasion of needed expansion (strategy finding) or the moment of refurbishment needs of a stock building (potential finding). Either case will allow the needed spaces to be realized in an energetically and environmentally optimized manner.

As can be seen in Fig. [2.14], illustrating the suggestions made here, the overall need for spatial expansion may only be reduced through internal reorganizations to a certain degree. This potential will be investigated in depth in the following chapter. Whilst the magnitude of space needed thus might not necessarily decrease by a major part, the proposed holistic approach would allow for more sustainable and efficient solutions to be found. The potentials of stock buildings should be exploited to the fullest through transformations, conversions or floor additions.

Looking Beyond ETH

It is clear to say, that there are limits to the potentials, which can be exploited within ETH's building stock. Whilst a significant fraction of the spatial demand can be expected to be coverable by these potentials, its magnitude remains to be derived through specific investigations.

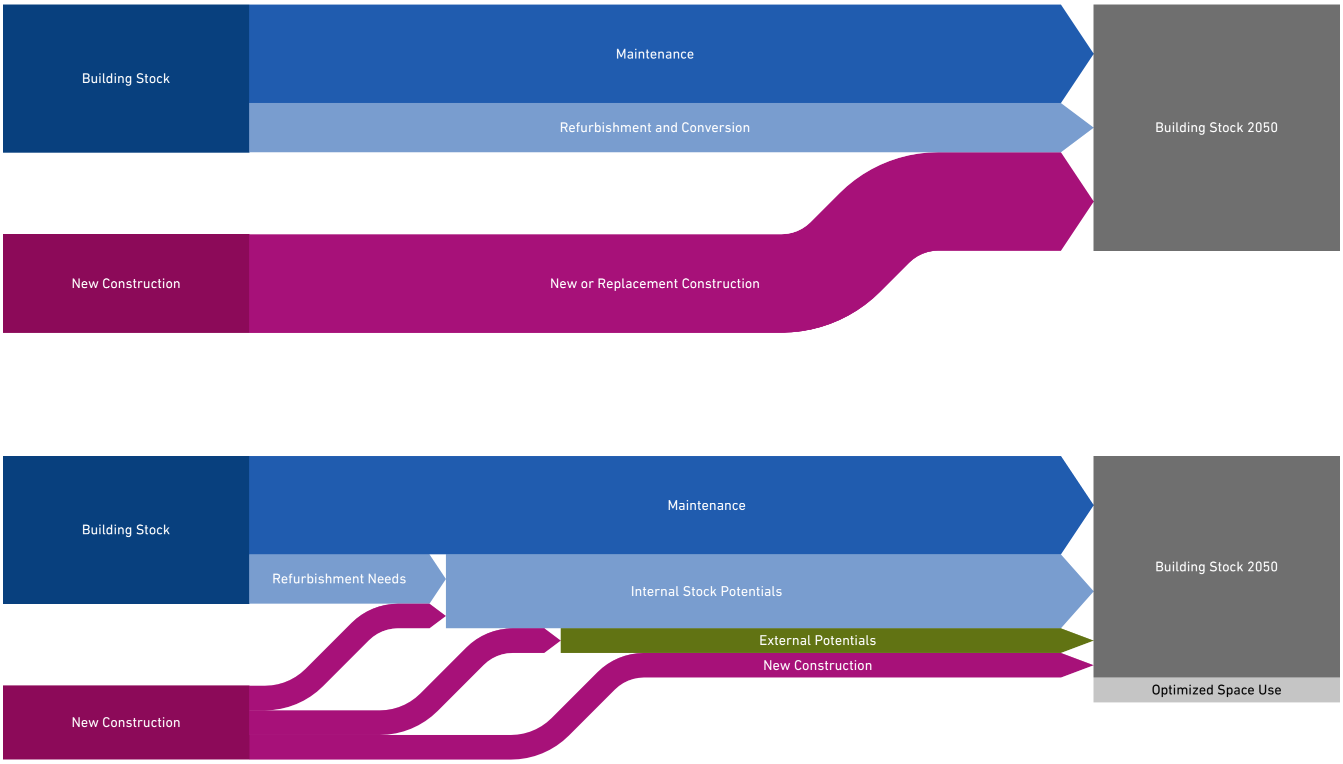


Fig. [2.14]: The current real estate management of ETH (top) features a strong division of maintenance, conversion and construction of new floor area. A more holistic approach, considering potentials of the current building stock of ETH and beyond, would allow for more efficient, environment friendly and less material-intensive solutions to be projected. All construction efforts should thus be put into a wider perspective, allowing to exploit structural potentials to the fullest (bottom).

As a further suggestion, the widening of ETH real estate management's scope of view can be proposed. In order to reach sustainability goals across the board, the issue may be approached on scales beyond ETH's own building portfolio. The city is a place of constant transformation, where various potential for internal development or densification remain to be uncovered. It can again be expected, that utilizing structural potentials in other parts of Zurich or Switzerland may make veritable contributions to a sustainable real estate development.

Involvement of Sustainability Goals

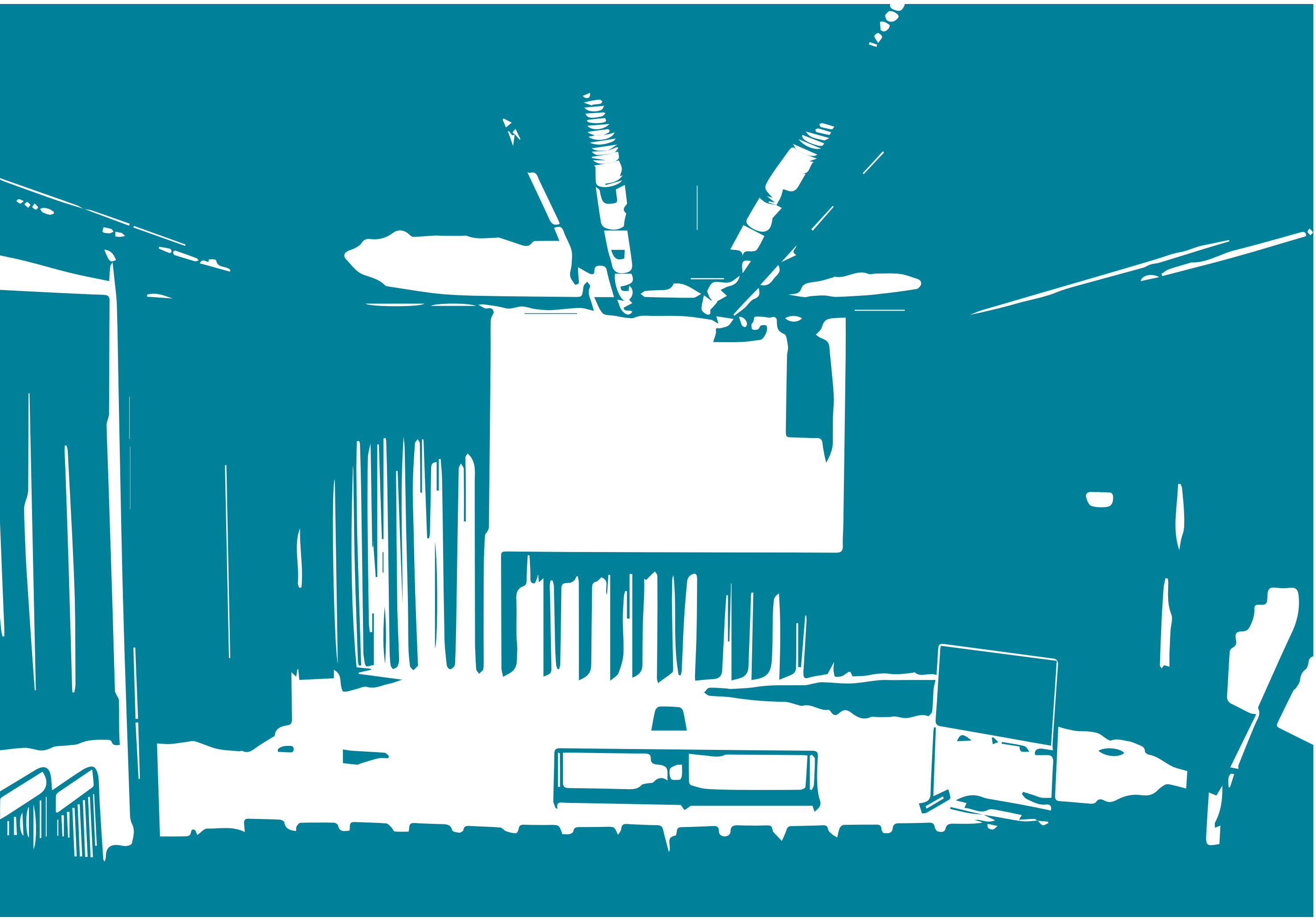
A last point of critique is the insufficient incorporation of sustainability regulations in the planning process of ETH. As has been presented, the Sustainability Guideline is currently only applied in the early project development phase, when the strategic approach has already been defined. It would be highly favorable to incorporate sustainability measures in an earlier moment of projects' development. Involving sustainability targets in the assessment of general strategies would make it significantly more effective and impactful. It can clearly be expected, that the biggest improvements in terms of energy efficiency and environmental friendliness can be achieved through strategic decisions, rather than in the succeeding planning of a project.

Whilst certain benefits of defining sustainability targets on a project-specific level must be acknowledged, making certain targets more binding and less exposed to the subjective assessment of an individual person in charge, would be desirable. Also in regard to the definition and evaluation of sustainability guidelines, a stronger systematic regulation should be considered.

Rooms for Future

Future for Rooms

"The outstanding infrastructure for teaching, research and knowledge and technology transfer is a key success factor of ETH Zurich. It helps attract both highly qualified personnel and exceptionally motivated, talented students, and enables them to fully develop their academic creativity."
ETH Zürich, Real Estate Strategy, Foreword, P. 5



Introduction

ETH Zurich finds itself in a period of growth, both in terms of people, but also in terms of space. The Master Plan 2040 foresees a duplication of the existing main usable floor area at the Hönggerberg Campus, the number of students will increase by 38% in the next 10 years and the number of employees will also grow. Only the number of professorships will slightly decrease. [3.1]

At the same time, however, the institution finds itself in a process of transformation. The Corona pandemic brought with it a wave of digitalisation that naturalised physical absence from the work- and studyplace and gradually paved the way for new forms of working and teaching.

Along all these changing parameters, the singular room is the protagonist in the role as a mediator. It defines the interface between human and excellent infrastructure, through which ETH Zurich strives to guarantee excellent performance of its students and staff. What do these "Rooms for Excellence" currently look like, how can they be adapted and do we even need new ones?

The main idea of our report is, and it tries to pick up on this in every subchapter and scenario, to take a critical position regarding the necessity for all the new buildings and the master plan in general. Thereby the question of whether we are using our existing building stock efficiently enough that these new building plans are even justified is at the very forefront of the discussion. If not, isn't it better to interweave future programs into the vacant spaces between the existing ones to foster more synergies?

By looking at this through the lens of the single room, we try to understand the current problems and come up with a number of recommendations for action. In order to do this, the future spatial development of ETH will be examined on the one hand at the level of studying and on the other hand at the level of working. In addition to that, the potentials of the current space of the portfolio will be examined and it will be checked whether they are used densely enough.

Each topic is dealt with in three sections: The status quo - a mapping, where the current situation and development is examined. A scenario - a possible future vision, projected onto the institution to overcome the bias and restrictions of the present thinking. And finally a status futura - a prospect, based on the insights gained of the scenario and other external sources, where possible interventions are discussed and recommendations for action are drawn up.

Catalogue of People and Rooms

To grasp the ongoing changes at ETH, the first thing we want to do is look at very simple statistics. In our catalogue we consider students, professors and the building volume. One notices that the number of students is increasing strongly, while the number of professors is actually decreasing, which means that the current students per professor ratio will change. In almost a decade, it will be more than 1/3 of the current students, which are at the moment representing 120 nationalities. [3.2]

The Master Plan 2040 foresees an increase in the already existing building volume of 1,210,000 m3 by a additional 690,000 m3 at the Hönggerberg campus. Since the location in the centre is limited by the city's surrounding building stock, the Hönggerberg must be able to both relieve it and respond to the ongoing growth. The larger goal that comes with this development is to revitalise the currently rather isolated campus and transform it into a quarter with urban qualities. [3.3]

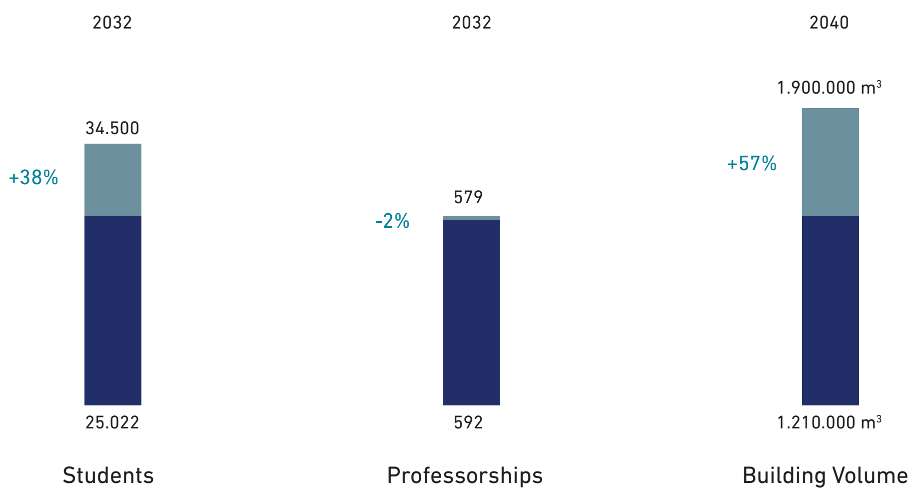


Fig. [3.1]: Catalogue of People and Space

Rooms for Excellence

In the competition brief for the newly planned HIC building on the edge of the Hönggerberg campus, the aim is to "enable and utilise synergies" and to "create flexible event, workshop and work spaces". The space programme includes places for the various ETH student associations to work together and create innovation. [3.4] Dedicated only to these organisations, the building and the people using it are completely isolated from other competences. The question arises as to whether this clear separation does not ultimately restrict cross-competence knowledge transfer and thus lose a lot of potential. Are there possibilities to enable more synergies on a broader scale by integrating the programme into the already existing inventory, instead of isolating it?

Another source, the "Handbook for Innovative Teaching Spaces at ETH", attempts to define flexible teaching spaces. It tries to explain how the spaces at the institution should respond to the changing conditions in teaching. An attempt is made to define ideal room types in order to provide better performance and occupancy rates. [3.5]

The importance of the design of spaces and their respective programmes is reflected in one of the main goals of ETH Zurich. After all, the excellent infrastructure and learning environment is among the most decisive factors in the university's international competition for the smartest brains and, accordingly, for its generel success. [3.6] In recent years, the demands placed on teaching have risen and changed constantly, requiring a constant rethinking of it and the spaces in which it takes place.

Digitalisation trends and major events such as the Corona pandemic are largely responsible for these changing circumstances. Through the integration of digital and hybrid forms of teaching, learning in general is changing from traditional frontal lecturing to more integrative and communicative scenarios. Knowledge can no longer only be acquired synchronously through on-site and distance teaching, but also asynchronously, in other words at individually determinable times.

In view of these fundamental changes, the classroom is becoming the focus point of re-thinking. After all, it plays a crucial role in the transmission of knowledge. It is not only expanding from physical to digital space, but also demands adaptations in its current design. Therefore it is not enough to just equip universities and students with digital devices; teaching and the spaces in which it takes place must be rethought and renegotiated as a whole. [3.5]

excellence, excellent

the quality of being extremely good

- The food was excellent.
- Her car is in excellent condition.
- The school is noted for its academic excellence.

(Definition of excellence from the Cambridge Dictionary of Business English)

Currently, there is a trend where everyone wants to have flexible spaces, which of course is limiting their specification - at least unless we are not longer bound to physical space anymore. How does ETH Zurich currently define the spaces that should promote excellence and how do they intend to to change them. Is the “Handbook for innovative classrooms at ETH” really that innovative?

Fig. [3.2]: Today’s teaching needs innovative and flexible premises, illustrated here with the example of a classroom at the Department of Architecture.

Fig. [3.3]: Series of pictures of ETH seminar rooms and auditoria

HG F 26.1

HIT F 31.1

CAB G 56

Status Quo

ETH Zurich's main goal is to remain an on-site university, whilst also sparsely incorporating hybrid formats. However, the traditional way of teaching is facing a change. From typical frontal lectures, teaching is increasingly moving towards new didactic scenarios that focus more on interaction and communication between students and teachers, but also between students and their peers. Since group work in general requires more space, this not only leads to new demands on the existing premises, but also to a greater amount of space needed per person. With the integration of hybrid formats, which in some cases make it possible not to have to be physically on site, this is already being counteracted. In this case, it is not necessarily more rooms that are needed, but rather more multifunctional ones, which means that they can accommodate several different teaching settings. By this frontal teaching, examinations, exercises, self-study, group work, block courses, other events and advanced education programmes are meant.

In order to respond to these transformations, the "Handbook for Innovative Teaching Spaces at ETH" was published in 2022. For this purpose a large number of discussions were held with internal and external teaching specialists and lecturers. The focus was purely on the spatial dimension of new concepts and not directly on how learning, teaching or examinations are carried out. Together with them, the current spatial situation was described and analysed in terms of building construction, (media) technology and infrastructure (especially types of furniture). This was then used to speculate on how it should change in the future in relation to the requirements of teaching and examination settings. The bigger goal of the handbook is to define ideal standardised teaching space types that will help planners in the future to design adequate classrooms "that support the teaching as well as the formative and summative assessment of subject knowledge and competences, the activation as well as the supervision of students".

According to the teaching formats included in the study regulations and as a result of the discussions, the two room types auditoria and seminar room were determined as the most important ones. These will be examined in more detail in the following with regard to their current situation and their future development. [3.7]

81 small seminar rooms (up to 49 seats)

34 small lecture halls (50 to 99 seats)

HCI J 6

HPH G 1

HG F 3

Auditoria - current vs. future

Currently, lecture halls only allow frontal teaching and are still the most widespread form of knowledge transfer for events with large audiences. Here, the blackboard is still a core element, which is often not compatible with another key instrument, the image projection by beamer. It turns out to be a difficulty to incorporate interactive formats, but lecturers do at least find a platform in the form of clicker questions and throwable microphones. But not only talkers and listeners have a hard time communicating - the design of the rooms with ascending rows and fixed seatings also makes interaction between students difficult. Particularly people with disabilities are severely restricted in their options to move around during group work. At the moment, additional formats such as hybrid and asynchronous learning as we got to know them during the pandemic are only rarely used at the ETH. This is because they do not create a sense of community due to the separate perspectives on the course. Therefore the auditorium remains a mainly physical space. Lecture halls should also be able to host Exams and they are currently often taken here at the end of the semester, but the rooms are, because only little adaptibility is possible, not ideal for this.

In the future, according to the ETH board, on-site lectures should still remain in the foreground because of their ability to promote a sense of community and interaction. Hybrid and asynchronous formats should continue to be considered only as a supplement. At the same time, however, the fact is recognised that the introduction of asynchronous formats (e.g. lecture recordings) would bring with it a fundamental change in the understanding of the teaching staff and the classes on site. It would offer more time for interaction between and group work amongst students and thus the possibility of more informal knowledge transfer. In that scenario the lecturer would act as a kind of knowledge manager, who roams around in seminar rooms and actively supports the students.

Spatially on the other hand, in order to achieve more collaboration among students during lessons, the intention is to replace upwardly ascending row seating with levels or flat halls without any fixtures at all. Rotating chairs, movable and height-adjustable tables, whiteboards and technical equipment for hybrid formats are seen as decisive components to help successfully achieve this. [3.7]

22 medium lecture halls (100 to 199 seats)

23 large lecture halls (≥ 200 seats)

Seminar rooms current vs. future

In general, the current furniture in the seminar rooms, in which exercises, seminars and projects can be held, is perceived as too inflexible. Switching between different teaching settings takes too long and thus leads to poorer utilisation rates. The technical equipment is outdated and limits the efficiency of learning. Currently there is a lack of power sockets, Wi-Fi coverage is insufficient and inadequate tools for group work restrict the students.

However, working in small groups, which will lead to an increase in space requirements, will become the core element of teaching in the future. This poses challenges especially for the rooms in terms of the variety of their usage possibilities. According to the handbook, in order to be able to switch between different formats and group sizes, furniture with wheels and tables with different shapes should be introduced. In addition seminar rooms must also be equipped with a wide range of new and old technologies that can be used side by side (beamer, camera, microphone, flat screen, blackboard, flipchart). [3.7]

Conclusion of the Handbook

According to the findings from the discussions with experts, there are therefore a number of challenges that ETH Zurich's rooms will have to face. In future, the focus will shift from large rooms that can accommodate many participants to smaller rooms that allow easier group work and interaction. There will no longer necessarily be a separation between the two teaching formats but rather they will merge into one another. In order to achieve this, ETH Zurich is primarily pursuing the goal of redesigning the existing rooms. To be able to accommodate different teaching formats they are planned to be equipped with the latest technical equipment and more flexible furniture. [3.8]

Fig. [3.4]: ETH's Flexible Auditorium, which is since 2014 located in the main building

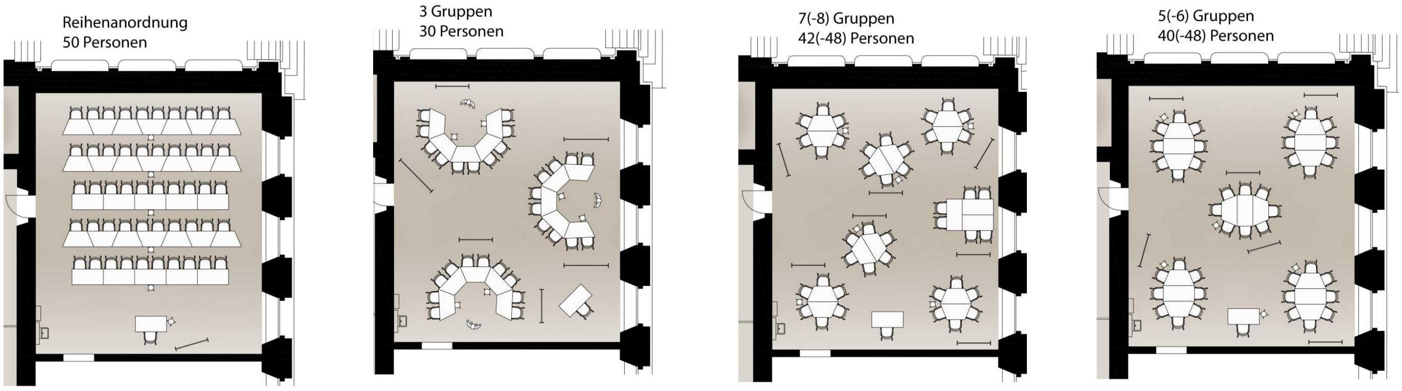


Fig. [3.5]: Varietey of different formats and group sizes that the Flexible Auditorium is capable to accomodate. This is made possible by furniture that is all on wheels. Currently, there is only one of these rooms at ETH Zürich.

The two types of building function

We have now looked at the buildings through the lens of classrooms, but there are of course other rooms that require more specific conditions - technology labs, microscopy rooms, isotope labs and others. In contrast to offices and seminar rooms, they demand very specific, technically precise environmental conditions such as vibration-free or precise temperature and lighting conditions. These rooms are essential for ETH Zurich, as they provide the infrastructure that attracts highly qualified professors and students. If we also include these rooms into our consideration of the Rooms for Excellence, overall they can be divided into two groups: ones with higher and others with lower requirements for specification.

If we now look at this on the scale of the buildings, we can see that this specification is not strictly separated. We find a mix of uses both in the already existing buildings as well as in newly planned ones as the HPQ on the Hönggerberg campus, which is still under construction. In the latter, only 53% of the rooms are actually laboratories. The rest are offices, service rooms or social areas. [3.9]

In the discussion about the need for new buildings, the question arises of what ETH, as a technical university, actually needs today and, above all, in the future. What sets it apart from others and accounts for its high position in university rankings is largely a result of the high-end research infrastructure that ETH offers. Therefore, in order to be able to continue to drive and lead in this field, it seems to be the top priority to improve them and makes them to a certain extent untouchable.

The future of traditional desk jobs is not so certain. With paradigm shifts in the world of work and emerging forms of hybrid working, they will be critically scrutinised and will inevitably be subject to a rethinking. ETH Immobilien already has a regulation requiring at least 80% desk sharing in new offices. This means that 10 people share only 8 workplaces, which requires a certain proportion of home office or part-time work. After all, the offices are currently already empty up to 50% of the time. [3.28]

So now the question arises as to whether it is justified to build 50% new office space in a new physics building? If there is already so much vacant office space, the aim should be to consolidate it before building new ones. A more sensible strategy could be to cluster necessary infrastructure that places high demands on the building and its surroundings. By separating generic areas such as offices from laboratories, the specifications of the buildings housing the infrastructure can be better utilised. After all, an office doesn't have to be vibration-free, but another laboratory might be. If generic spaces are then too clustered together in one building they can, in the event of under-utilisation, be shared, used temporarily or rented out on a long-term basis more easily

WHAT IF?!

mETHaverse

2m ago

13.09.2035
The long-awaited revision of the teaching system at ETH will finally be implemented from this semester onwards! For the first time, the Architecture degree programme will now be offered entirely in the mETHaverse. This means that students can study from anywhere and at any time, with student autonomy being the top priority!

Read by the avatar of Professor Fabio Gramazio:

Dear students,
you have successfully enrolled for the first semester of architecture at mETHaverse. For the introductory lecture, we will be gathering for a virtual tour through the former main building of the university. The access link and 3D-File for this will be sent to you in near time. Afterwards, there will be a group work session where you can get to know each other better in break out rooms. You are all invited to work out your own designs for the rooms and to then introduce them to your fellow students.

Please log in by 10:00 a.m. at the very latest so that we can start on time.
Be sure to have enough memory, a good internet connection and a power supply to ensure that everything runs smoothly.
If you have any problems accessing the required mETHaverse platform, please do not hesitate to contact our IT team.

We look forward to the coming semester with you and wish you a good start.

Professor Fabio Gramazio
Chair of immersive architecture
ETH Metaverse

40.000
Students

1.87x
better results in exams

92.000
terabyte data storage


Free.

Status Futura

In 2035, if digitalisation trends continue to advance at a rapid pace and the accompanying technologies are made available more cheaply to the broader public, emails as we know them today could face a redefinition.

The continuing transformation to an increasingly complex and technology-based society also places new demands on our education system. Many characteristics of the teaching methods (frontal lectures for example) used at universities are legacies from the 20th century and do not adequately prepare students for the uncertain future of the world of work. In an era characterised by increasingly global challenges, skills such as critical thinking/reasoning, creativity/creative thinking, problem solving, collaboration and communication are becoming even more important. There must therefore be a renegotiation of teaching methods and thus also of the spaces in which excellent performance is to be achieved. Immersive extended reality (XR) technologies such as the Metaverse can bring in helpful options in the discussion to successfully respond to these requirements.

Even with the goal of remaining an on-site university, it makes sense for ETH Zurich, especially regarding the fact of being one of the worlds leading technical universities, to integrate the thinking of virtual space into its development strategy as early as possible. In the current "Handbook for Innovative Classrooms", such "purely digital teaching and asynchronous settings" are not examined at all. What is clear, however, is that it is not enough to just equip the current rooms of universities with digital devices, but it is rather a matter of rethinking teaching as a whole. Physical and digital space are both components of this process, which must be considered integrated as one space of learning. [3.5]

In the following, an attempt is made to learn about the potentials of an integration of the virtual space into teaching and by doing so, gaining insights from it about an adequate planning of our physical spaces. How can the hyperflexibility that can be realised by simply putting on VR glasses and loading a 3D file affect our current spaces and how does this respond to the new requirements of teaching, which is putting the focus on project-based work?

What is Metaverse

The term was first used by science fiction author Neal Stephenson in his 1992 novel "Snow Crash". Here he describes the Metaverse as a virtual world composed of unique environments, each with a specific purpose: to entertain, socialize, educate, and more. Using head-mounted displays, smartphones, and other media technology, people could enter these shared spaces and engage with one another regardless of their location. In other words, one could call Metaverse the next iteration of the internet that shifts from the limitation of 2D graphics on flat screens to immersive 3D environments. It will be able to create a virtual and interactive equivalent of our physical world that we can explore through extended reality Platforms, called XR. [3.10]

Extended reality includes three different immersive technologies that allow to access the metaverse: augmented, mixed and virtual reality. In ascending intensity, they describe the inclusion of virtual elements in our perception of physical space, whereby they are only complementary in the first two and completely replace it in the latter. [3.11]

These methodologies offer a variety of options that allow for a carefully selected and creative involvement in the design of lessons that can take totally different styles and respond to the current educational needs.

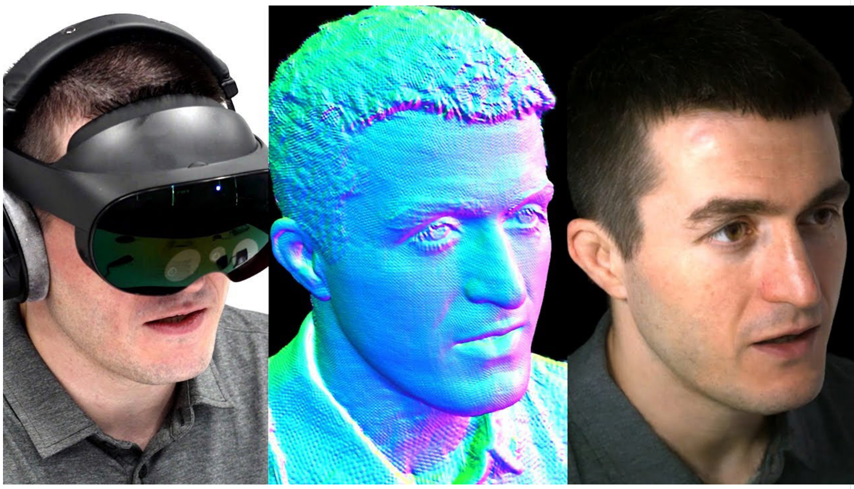


Fig. [3.6]: IT specialist and Youtuber Lex Friedman in a podcast in the Metaverse with Mark Zuckerberg. It shows the new, much more realistic possibilities for designing avatars. From left to right: Lex Friedman with Quest Pro headset, 3D Scan, the final avatar.

4x	275%	3.75x	4x
faster to train than in the classroom	more confident to apply skills learned after training	more emotionally connected to content than classroom learners	more focused than their e-learning peers

Fig. [3.7]: Results of a study on the use of Metaverse for learning, which PwC conducted in America with 6000 participants.

Advantages of immersive learning

Increased engagement: XR-enhanced learning environments increase the interest, the enjoyment and the motivation of learners. A study conducted by PwC (one of the world's leading accounting and consulting firm) shows that learners are more than twice as confident in applying the skills acquired in the metaverse because they have appropriated them as a realistic, more engaging practical experience.

Personalisation: XR allows virtual spaces to be adapted according to personal preference, making them more responsive to users. This leads to an increase in efficiency and a greater ability to concentrate.

Possible Visualisation: XR makes it feasible to visualise things that are not possible in the same way in the physical world. Abstract concepts such as the structure of cells or the theory of relativity can be presented visually and spatially in order to support learning. Access to expensive devices and equipment for experiments that would otherwise be impossible for students could also be guaranteed without risk. This would allow students to benefit from ETH's first-class infrastructure on a broader scale.

Active Learning: It will be possible to learn and interact with real-looking objects. In this way, high-risk or high-cost scenarios such as medical operations or using expensive machines can be carried out. A study conducted with maths students in Ohio showed that the group that learnt with the support of XR performed 11% better than the one with traditional teaching.

Field Trips and Exchange: XR makes it possible to visit relevant, more authentic places for learning than the classroom that would otherwise be inaccessible. Therefore Interesting excursions can be organised that broaden the learners' field of vision. In addition, meetings and exchanges with different people can be facilitated over longer distances, which promotes collaboration and communication internationally and in general.

Disadvantages of immersive learning

Cognitive load: Learning with XR involves a lot of auditory and visual information, which can lead to a stimulus overload. It is therefore not conceivable to replace the full volume of teaching and is seen more as a supplement.

Affordability: At the moment, XR technologies are still much more expensive than conventional learning materials such as books and laptops and in most cases require a fast internet connection. Creating materials for immersive learning platforms is also more expensive and requires specialised equipment and skills.

Privacy and Safety: XR platforms are often run in co-operation with companies whose aim is to collect as much data about their users as possible. Through XR they are able to capture images, movement, performance and emotions of customers. This raises the question of how to protect the data of learners and their privacy.

Less real life: By spending time in the metaverse, less time is spent in the real world. This can lead to people neglecting their real body and their connection to their social and natural environment. Doing so can lead to physical and psychological complications. In a more pronounced stage, this can lead to addiction. [3.10, 3.12]

Imagine standing in your living room, but feeling as though you are exploring the ocean floor alongside a friend who lives on the other side of the world. This is possible in the Metaverse.

Reasons for and possible implementations of XR at ETH Zürich

The possibilities offered by extended reality provide the basis for the realisation of necessary new horizons in the field of education. Especially as one of the leading technical universities and with the aim of offering its teaching staff and students the highest quality of infrastructure, ETH Zurich should promote and test the inclusion of virtual space as early as possible.

In the Handbook for Innovative Teaching Spaces at ETH we read not only about outdated rooms, but also outdated teaching formats. By incorporating extended reality technologies into the physical learning space and utilising all its potential, both problems can be addressed simultaneously and therefore significantly increase the quality of learning.

Currently, however, there is still very little use of XR at ETH Zurich, although there are already a few isolated examples. For example, in the Department of Architecture. The Immersive Studio, a design studio opened by Professor Fabio Gramazio in 2022, is trialling the integration of XR into architectural teaching. The aim is to use VR headsets to directly link design with its experience in 3-dimensional space and by that get a more sensual understanding for the planned project. The aim is to familiarise architecture students with advanced visualisation methods and prepare them for the changes that are emerging in the world of work. [3.13]

Such spatially visual learning methods would also help to understand complex concepts in many other degree programmes offered at ETH. It is often difficult to enable students to learn on certain machines and with the help of special experiments due to the high costs and risks involved. ETH's excellent infrastructure, which could offer valuable practical experience and preparation for the future world of work, is therefore often reserved for trained researchers only.

With the help of VR glasses and digital twins, this type of infrastructure could be made available to a broader range of students at low cost and without risk. Simulations of medical operations, the performance of dangerous experiments or the use of expensive machines can be learnt in an immersive way and by that equip students with necessary skills.

Traditional frontal teaching, which is increasingly criticised by education experts, can also be replaced by XR. With the support of specialists, teachers can create material for immersive learning in virtual space, which can then be acquired asynchronously by the students. This makes it possible to be independent of time and place and responds to the individual preferences of the learning environment. Consequently, the efficiency and motivation of students can be increased significantly. An architecture lecture on the Farnsworth House by Ludwig Mies van der Rohe, which is located Chicago, would therefore no longer have to be learnt via pictures and a lecture in the auditorium, but could be held in a virtual twin. Explaining human anatomy in medical degree programmes could take place in a virtual tour of the human body. This would make abstract concepts that are normally difficult to visualise easier to understand. Students would be offered a far more integrative acquisition of knowledge. [3.10]

"The future of education at Harvard is brighter than it would have been without the pancemic."

Provost Alan Garber, Harvard University

It is important to emphasise that extended reality should only ever be seen as a supplement and not as a replacement for physical exchange. Students would continue to meet on site after they acquired the relevant knowledge separately through XR learning material. At the university they should find themselves in upgraded seminar rooms where they could consolidate their knowledge in a project-orientated manner in group work. [3.14] The teaching team would also be present and support the students much more informally in the role of a knowledge manager. [3.7]

As a result, a large proportion of current lecture halls would become obsolete and seminar rooms would simultaneously move further into focus. Auditoria could also be converted and upgraded to rooms suitable for group work, providing an important resource in the growing demand for space.

Also the learning environment in physical seminar rooms can be supplemented and enhanced with XR. Augmented reality is particularly suitable for supporting physical practice, such as building an engine, with virtual aids. For example, you could be shown, through smartphones, tablets or simple glasses where a screw needs to be fitted or what percentage of the work has been completed already. This would improve the quality and possibilities of group work far beyond current tools such as whiteboards and projectors.

By making it possible to spend some of the teaching time away from the university, the large number of students could be spread over the week and would therefore require fewer rooms overall. This would relieve the load on the current stock on the one hand and ultimately even reduce the need for new buildings on the other. By including virtual space, XR would therefore revolutionise teaching and provide an answer to the emerging question of space, which is closely linked to the ecological and economic development of ETH.

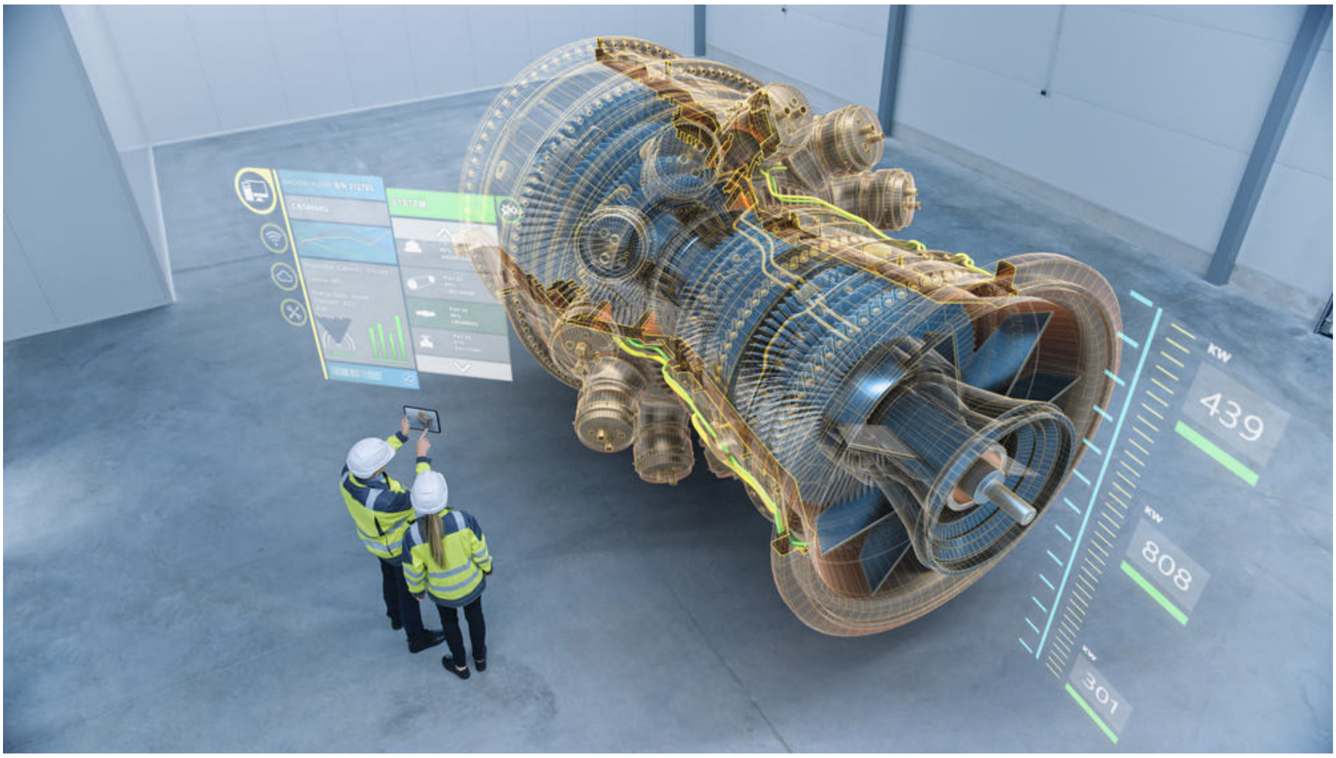
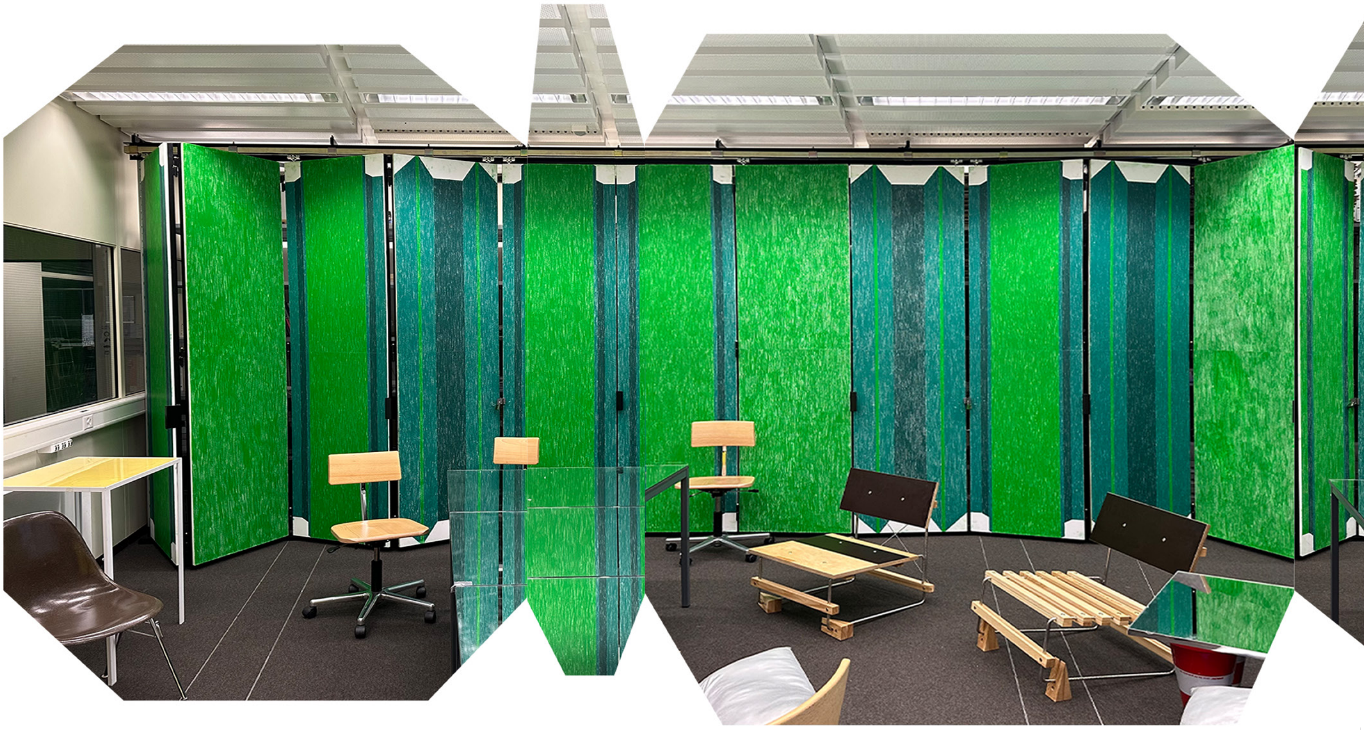


Fig. [3.8]: The image shows a possible application of AR technologies in degree programmes such as mechanical engineering. Three-dimensional visualisation and additional information as support should improve learning.

Learning from Emptiness

Do we really need a specific space or even a specific building for every single programme? Can't we create more synergies by designing spaces where a number of different activities can take place? What if we interweave newly planned programmes into the existing ones?



«ETH Zurich focuses on consolidating the use and increasing the density of existing buildings.”
Principle 7, Real Estate Strategy ETH Zürich, P.33

At the moment, this quote is still more an optimistic goal than a proven reality. Currently a lot of rooms at ETH Zurich remain empty and unused for a considerable amount of time throughout the course of the year. Thereby it seems not to matter if a room offers specific or generic possible usages.

This vacancy is not only to be found during the longer semester breaks, but also at other times throughout the year, both within and outside of teaching hours, in other words throughout the day, in the evenings and at weekends. Despite the obvious potential and also goals of densification and development in the existing building stock of the ETH board, the focus is currently still on building new spaces for upcoming and additional programmes.

Considering the fact that ETH Zurich is facing an increase in the number of people and, as a result, an increase in space, the existing buildings and their vacant rooms will be examined as a resource in the following. The unused spaces also offer attractive potential for the goal of the Masterplan 2040 to transform the Hönggerberg Campus into an urban district and are tested in that direction.

In the following, the Departement for the Future (of) Rooms looks into potential ways to manage the current room portfolio more economically and ecologically. As a result a few proposals for action are made.

Fig. [3.9]: The office space of the Jan de Vylder Chair in the HIL building on the Hönggerberg campus is open to all others outside of their own use. They call the concept that they set up "Ours/Yours Office". It provides students with a separate, calm workspace that is ideal for group work.

Status Quo

As a foundation for the following study of the existing inventory of spaces, it is referred to a research paper on the occupancy density of the teaching rooms at ETH Zurich. It was conducted in the autumn semester of 2019 and published by the Academic Services Department in November 2022.

Here, the 160 teaching rooms of ETH, which are distributed around the main building in the city center and on the more isolated Hönggerberg Campus, are differentiated and analysed in four categories:

- 81 small seminar rooms (up to 49 seats)
- 34 small lecture halls (50 to 99 seats)
- 22 medium lecture halls (100 to 199 seats)
- 23 large lecture halls (≥ 200 seats)

The teaching hours were defined from Monday to Friday from 8 a.m. to 7 p.m., with the semester lasting from calendar week 38-51. [3.15]

It is important to emphasise that the study works with data collected before the coronavirus pandemic. According to our own sample analysis, it can be stated that the number of bookings has generally decreased slightly, but remains comparable. However, fewer pupils are now actually on site due to different preferences of learning combined with additionally offered digital teaching settings, resulting in less crowded classrooms. The general shift in teaching formats from traditional frontal lecturing to integrative and communicative formats that is already happening means that smaller rooms, which allow for group work, are becoming more important. In the longer term, this will lead to a reduction in the need for larger lecture theatres and a simultaneous increase in the demand for smaller rooms.

105 Räume	Belegungsdichte Zentrum				
Uhrzeit	**MO**	**DI**	**MI**	**DO**	**FR**
08:00 - 09:00	38%	52%	47%	72%	79%
09:00 - 10:00	71%	61%	63%	77%	85%
10:00 - 11:00	84%	69%	86%	97%	85%
11:00 - 12:00	94%	68%	86%	96%	76%
12:00 - 13:00	12%	18%	14%	20%	30%
13:00 - 14:00	84%	91%	79%	79%	91%
14:00 - 15:00	83%	89%	83%	85%	83%
15:00 - 16:00	88%	87%	85%	87%	26%
16:00 - 17:00	79%	84%	77%	71%	17%
17:00 - 18:00	34%	41%	36%	34%	8%
18:00 - 19:00	14%	25%	22%	22%	5%

55 Räume	Belegung	
Uhrzeit	**MO**	**DI**
08:00 - 09:00	44%	42%
09:00 - 10:00	73%	76%
10:00 - 11:00	82%	60%
11:00 - 12:00	80%	55%
12:00 - 13:00	22%	44%
13:00 - 14:00	42%	84%
14:00 - 15:00	51%	69%
15:00 - 16:00	53%	44%
16:00 - 17:00	51%	69%
17:00 - 18:00	36%	47%
18:00 - 19:00	11%	27%

Fig. [3.10]: Study published by the Department of Academic Services of ETH in 2022 on the occupancy rate of the university's Eduspaces in the 2019 autumn semester.

Vacancy withing teaching hours
The analysis shows the percentages of occupancy of the classrooms at the respective locations. It found that all teaching rooms are occupied at an average rate of 60% during teaching hours. The worst occupied times are particularly noticeable in the morning, at midday and in the evening.

Between the individual types of rooms there are only deviations of a few percent, just as between the examined locations Hönggerberg and Zentrum. According to the academic services, the result is very satisfactory and the classrooms are used almost to their maximum capacity. [3.15]

Another problem that leads to vacancy is the double occupancy of certain rooms by students who have been assigned a fixed workspace at ETH. Architecture students, for example, occupy a desk for the whole week, although they are only on site for a fraction of the time. Simultaneously to this, they need places in lecture halls and seminar rooms.

Vacancy beyond teaching hours
It is striking that almost all of ETH's classrooms remain unused outside of teaching hours, in other words, on evenings and weekends. Lecture halls, seminar rooms and meeting rooms are usually locked after the officially authorised use by reservation.

The study does not record any data on this, but if one looks at the occupancy plans for the current semester HS23, only rarely can an exception be found. Although the rectorate rooms can be rented by external persons outside teaching hours, it does not happen very often. This is because it quickly becomes expensive (small seminar room half-day 200 CHF, large lecture hall half-day 1000 CHF) and therefore unattractive. [3.16]

Vacancy during semester breaks
Twice a year, ETH Zurich has an extended semester break. After the autum semester, this usually lasts 57 days, after the spring semester 107. During this time, many classrooms remain empty for long periods at a time. The Academic Services study does not record any data on this either, but if one looks at the current occupancy plans again, only little commitment can be found. At the moment, a few of the rooms are opened for students to study or reserved for exams, but by no means all of them. It is not only specific rooms that remain empty, but also generic spaces such as design studios.

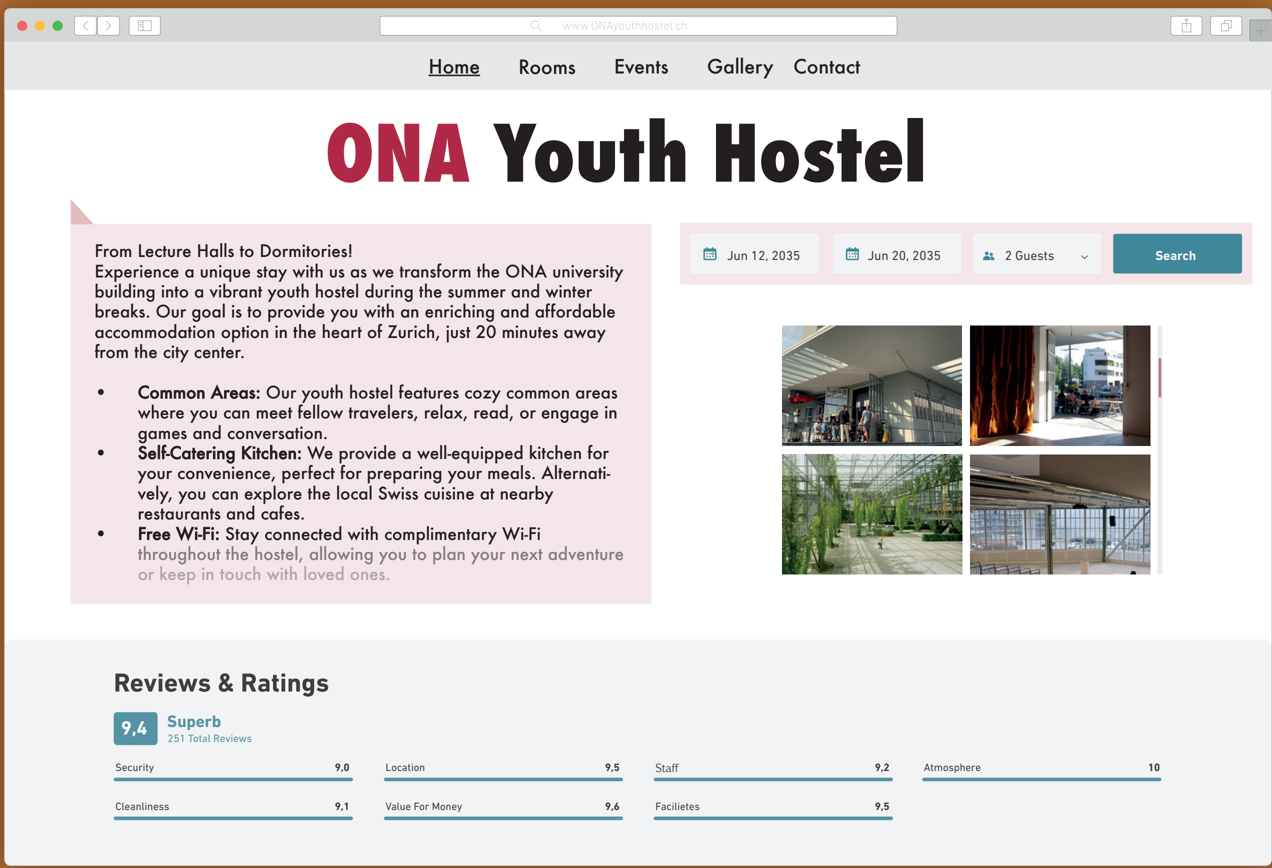
If one includes the higher vacancy rates of the ETH room inventory over the semester breaks into the 60% occupancy of the rooms during the semesters, it is a lot less with only 37% usage per year.

sdichte Hönggerberg		
MI	DO	FR
71%	62%	56%
80%	80%	75%
82%	65%	89%
73%	82%	85%
40%	64%	37%
67%	78%	91%
62%	84%	87%
95%	95%	78%
58%	69%	46%
29%	51%	6%
13%	29%	0%

With this data, the analysis of space utilisation draws attention to the fact that ETH Zurich still has quite a bit of potential when it comes to following the 7th principle of its real estate strategy, which focuses on densifying the use of the already existing building stock. By doing that the justification for the number of newly planned buildings in the Masterplan 2040 is put into question.

WHAT IF?!

The number of students is increasing as expected, but many rooms, especially external locations, are still underused. At the same time, the climate crisis is getting closer and closer to people's hearts. The state is cutting ETH funding in order to be able to react to the consequences and the institution itself also wants to become more ecological. This finally motivates to rethink the existing premises to the limits of imagination and to release their full potential...

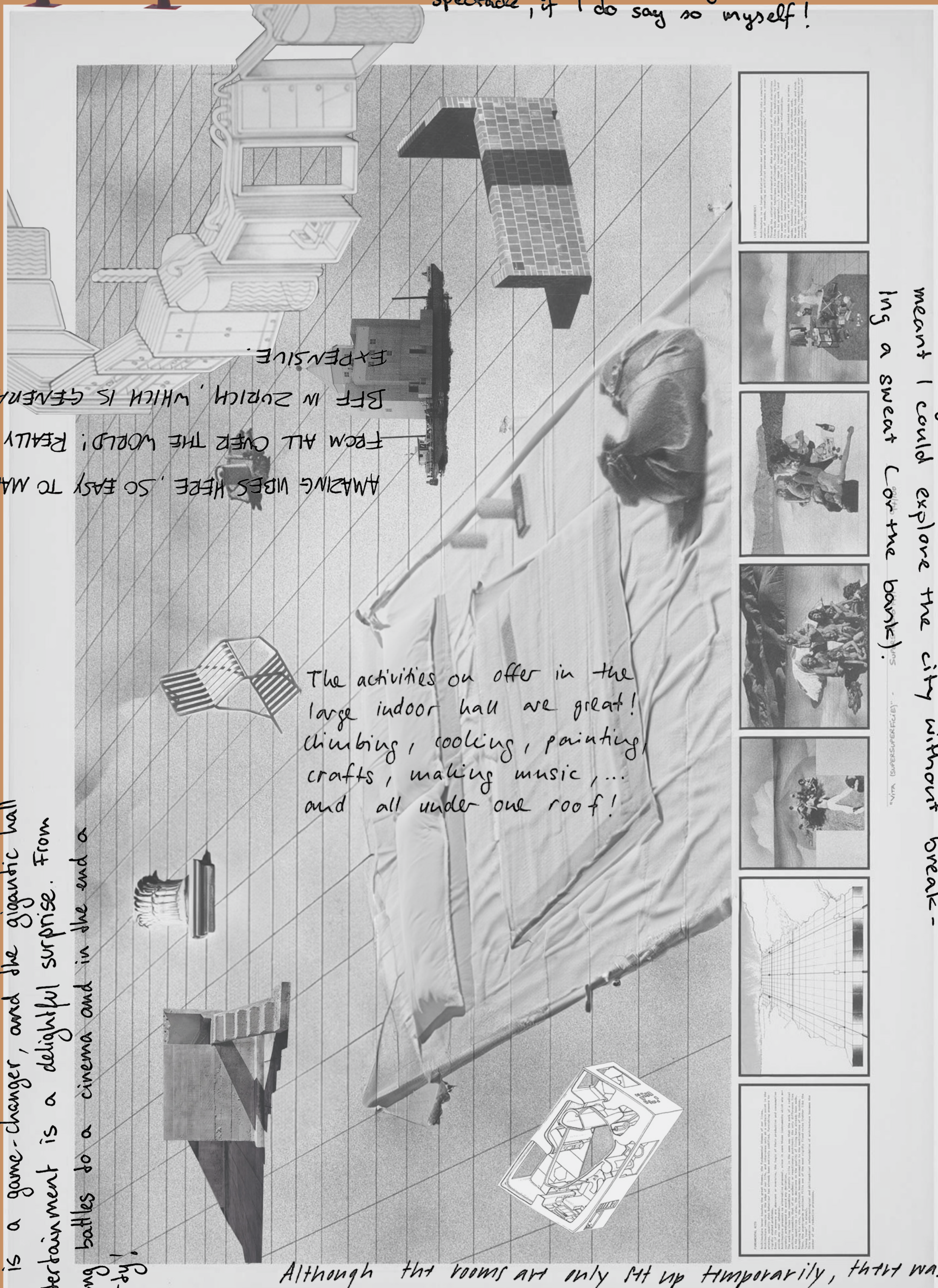


150
beds

19.800
possible overnight stays

792.000
CHF revenue (40 CHF/ night)

It's like a playground for grown ups!! I joined in on a yoga class, challenged newfound friends to a chess championship (spoiler alert: I lost), and even tried my hand at salsa dancing. – quite a spectacle, if I do say so myself!



Want to have a nice study break?! I discovered this university-hostel wonderland, and it was like hitting the jackpot! The central location meant I could explore the city without break-ing a sweat (or the bank).

AMAZING VIBES HERE, SO EASY TO MAKE FRIENDS FROM ALL OVER THE WORLD! REALLY YOUR WALLETS BFF IN ZURICH, WHICH IS GENERALLY QUITE EXPENSIVE.

The activities on offer in the large indoor hall are great! climbing, cooking, painting, crafts, making music, ... and all under one roof!

This university-turned-hostel is a hidden gem in the heart of the city, offering cozy, budget-friendly rooms engaging with people. The central location is a game-changer, and the gigantic hall of entertainment is a delightful surprise. From ping-pong battles to a cinema and in the end a big party!

Although the rooms are only set up temporarily, there was no lack of comfort! For my part, I really liked the raw and industrial atmosphere a lot, and so did my bank account!

Status Futura

With the goal of making ETH more ecological and economical in mind, densification of use becomes the most decisive factor. The potential in this respect in the existing building stock is still large and shifts the planned new buildings into a critical perspective. Many rooms at ETH Zurich are ideally suited to be opened after class hours or on weekends for external or internal people. The rooms are heated anyways, so why not use them?

Particularly with the aim of the Masterplan 2040 to transform the Hönggerberg campus into an urban quarter, it would be attractive to make temporary uses more interesting to also attract people who do not normally belong to the campus bubble to the area. Currently and in the future, this needs to be encouraged to improve the difference in people, urban situations and with that overall urban qualities. It is not enough to just try to integrate the campus into the city, we have to start integrating the city into the campus.

Already today there are a few actors within the institution, who are actively dealing with the vacancy problem and try to tackle it. They are testing the potential of generic spaces or alternative uses of rooms that enable a denser and more attractive use. By looking at their work as a reference, we are trying to rethink the premises of the ETH.

Jan de Vylder Ours/Yours Office

Instead of locking doors, one can lock materials. This is the concept that Jan de Vylder applies to the office of his studio in the HIL building. If they don't need the space themselves, they lock all their stuff in a wall cabinet, which is transforming the room itself into a neutral surface. Free from restrictions by specifications, the office area is now open to everyone and helps to reduce the unusablity of space due to vacancy. The space is a valuable resource for students and is actively used. In contrast to the large drawing rooms in the neighbourhood, it offers the opportunity to work in silence or discuss things in small groups without being disturbed. We can already see from this example that available storage space plays a key role in the success of flexible spaces. [3.17]

HCI's Hidden Pub

Shortly after the HCI building was constructed in 2004, Professor Paul Smith set up a rather unusual common room. In the basement of the building, he built a "Hidden Pub" using materials from an English pub that was to be demolished. It can be used in many ways for meetings, discussions or team-building events and often turns out as an enrichment to work life. To this day it is, by the staff of the Materials Science Department, considered to be a high-quality common room that fosters informal knowledge exchange. The room is used almost daily, which shows its popularity. It is a good example of a different approach to designing spaces which actually encourage informal knowledge exchange and are used rather densely. In contrast, the common rooms as we build them today, for example the lately realised ones i the recently completed HIF building, have an anonymous character and are not inviting. As a result, they are only sparsely used and thus become empty, wasted spaces.

Fig. [3.11]: The "Hidden Pub" lives up to its name - the only picture that can be found on the internet dates back to 2005.

Fig. [3.12]: PolyLAN 2018 held in the HXE building on the Hönggerberg campus

PolyLAN

PolyLAN is the biggest Lanparty in Zurich. At a LAN party, people all get together with their own gaming consoles in one place, where they connect to the same LAN (local area network) and play video games. There are two multi-day events per year, organised by part of VSETH. They take place within the premises of ETH Zurich and offer the participants the possibility to sleep, shower, have breakfast and, of course, game here. PolyLAN is one of a few examples of how the campus and its premises are revitalised outside of teaching hours. It is an excellent illustration that shows what is possible in the buildings if we think about their full potentials. In the end, it is only us who limit the use of the spaces by thinking about them with too little imagination. [3.18]

Scenario ONA as a Youth Hostel

Entire buildings, especially external locations like the ONA in Örlikon, are completely empty during the course of the semester breaks. Altough, their central location often makes them ideal for other interim uses. The example of PolyLAN already showed us that it is certainly possible to live at ETH for a short period of time - can't we extend that potential and set up a youth hostel for longer periods of emptiness like during the semester breaks?

By trying to follow the creative path of these active individuals, we want to learn about the future by creating a possible one, that is for now stated as unfeasible.

During the semesters, the ONA building is mainly used by the Department of Architecture while during the examination phases, a few rooms are reorganised for writing exams. However, despite being heated, a large number of them remain totally empty for most of the time of the semester breaks. By studying the floor plan, it turned out that the smaller rooms on the upper floors offer quite some potential to be subdivided using modular systems. By doing so they could be transformed into dormitories and private rooms. The large hall on the ground floor in contrast, allows, throught its generic character, to host a variety of programms. It can be opened up to the wider public and used as a climbing hall, communal kitchen, restaurant, workshop space, yoga studio or similar. The focus hall can still be used to hold lectures, stage performances or watch films and thus enhance the urban qualities of the neighbourhood.

As a youth hostel and community center, the ONA of the future could be offering travellers affordable, centrally located accommodation, enrich the neigbourhood, reduce cost of ETH and above all, reduce $CO2$ emissions through unnecessary heating and vacancy.

Other options to reduce vacancy

In order to further increase the density of use, the examples of these pioneers should be followed on different scales and the implementation of such transformations and temporary uses should be facilitated. The unique availability of rooms at ETH Zurich offers countless possibilities for creating reasons why students and people who do not belong to the campus bubble would want to stay on the premises outside of class hours.

Lecture halls offer the ideal architectural conditions for performances, film events, concerts, theatre or other evening programmes. Currently, however, renting a lecture hall for 4 hours costs up to CHF 1000 and is accordingly little used. These prices should be reduced and the use should be made available more easily. [3.16]

The large generic areas of the design studios of the Departement of Architecture stand empty for long periods of time during the semester breaks. Often they are being locked. In the meantime, they could be used as exhibition space for upcoming artists or architecture students. GTA Verlag is a good example of this. They use the foyer areas of the HIL building with changing exhibitions throughout the year, making them an attractive space instead of just a zone for circulation.

Also specific rooms such as the laboratories or computer rooms are often empty at ETH. To use them outside of teaching hours is of course a bit more complicated, but still a promising ressource. For their utilisation, trained personnel and negotiated contracts are needed, but there is an ideal clientel for that. The semester breaks in the summer of high schools in the surrounding area does not start until 5 weeks after the one of ETH, which means that block courses in the lab rooms can be an attractive way for them to make lessons interesting and enabling project-based experiences for students. Computer rooms could also be used for the wider, less specialised public to hold computer science courses. After all, the programmes are all there. Other specific spaces such as the Raplab, a workshop with various machines and tools in the ONA and HIL, which are mainly used just before the architecture students' final exams, could be made available to the general public the rest of the time. After an introductory course and logging in with an account, anyone could use the equipment.

ETH is characterised by its specialised infrastructure, but many people are denied access to it. Can we not share it and thus create benefits on a broader scale?

Raumbezeichnung	Platzzahl	Mietpreis	
		½ Tag (bis max. 4 h)	Ganzer Tag (über 4 h)
Seminarraum ohne Beamer		200.00	250.00
Seminarraum Standard	bis 50	280.00	350.00
Grosser Seminarraum / kleiner Hörsaal	51 - 100	450.00	600.00
Mittlerer Hörsaal	101 - 150	700.00	1'000.00
Grosser Hörsaal	151 - 299	950.00	1'250.00
Sehr grosser Hörsaal	ab 300	1'250.00	1'750.00

Fig. [3.13]: Rental prices for the Rectorate rooms at ETH Zurich in CHF

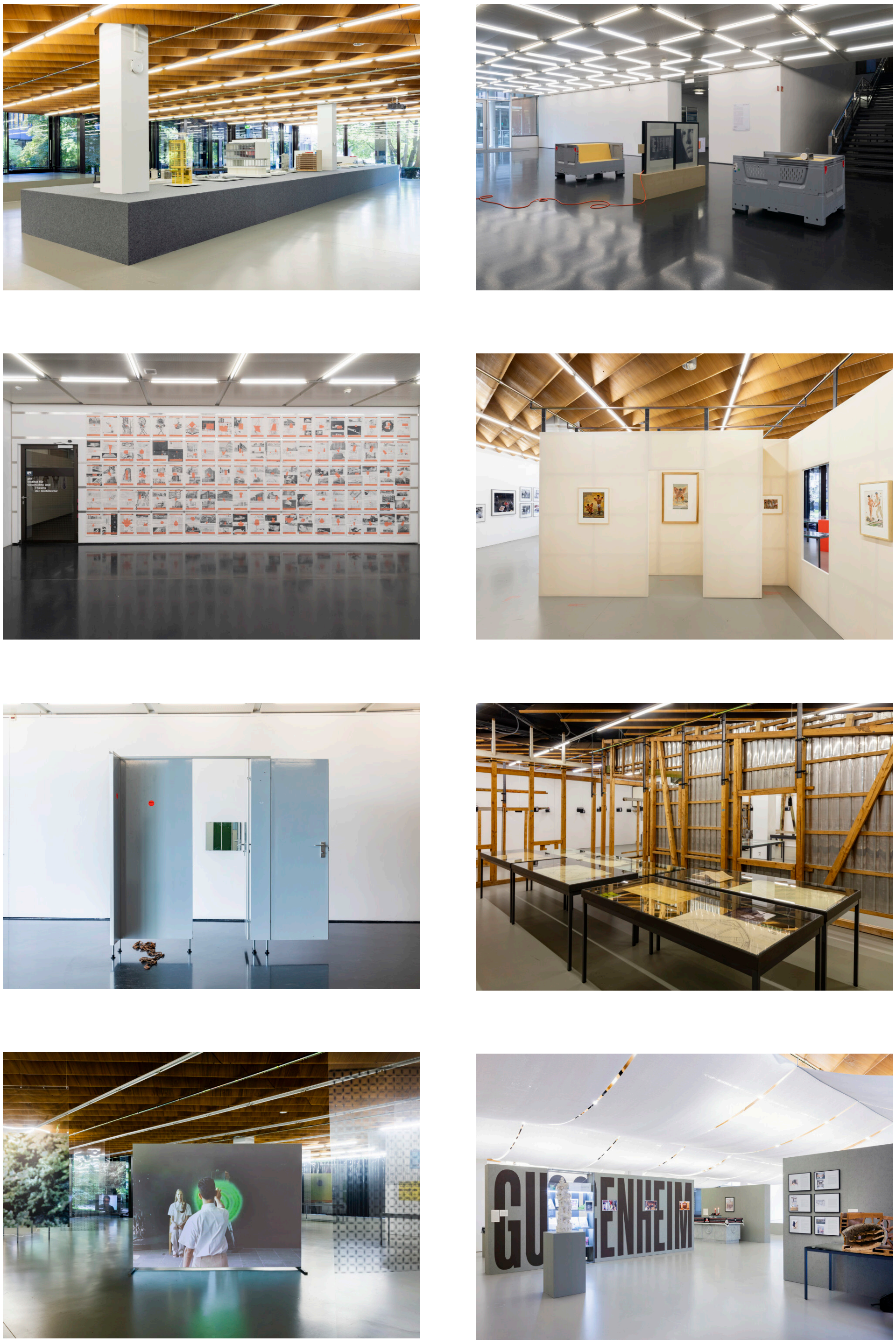


Fig. [3.14]: Series of pictures of past exhibitions of the GTA Verlag in the HIL Foyer

Future of Work

The way we work is being redefined, and with it the way we live and build. As time goes by, homes are becoming home-offices, offices hybrid spaces and discussions Zoom calls. But how do these hybrid spaces that connect the office to the home look like ? And does the perfect home-office even exist yet ? Is there ultimately a risk that people will only work from home ?

> «The future of work that we thought was ten years out, Covid brought us to that future now.» [3.20]
>
> Michelle Kaufmann,
> Head of Google's future offices

As Michelle Kaufmann says, the process towards a new way of working has been accelerated by covid. During the pandemic, solutions were found quickly, thanks to applications such as Zoom or Teams. These have considerably changed the way we communicate with our colleagues as well as our interaction with the work site. At first temporary, these solutions are now becoming the norm, and hybrid working has become essential for many people.

As this new way of working takes hold, its consequences are also being felt. Offices that were completely emptied during the pandemic have seen their occupancy rates rise again, but to levels that are clearly lower than pre-pandemic ones. [3.19]

This phenomenon raises a fundamental question about the future of the office: is it doomed to disappear? Indeed, hybrid working has now become the norm and made home-office an attractive working arrangement. Although this situation still seems extreme, the way we work is changing, and with it the spaces in which we work are being redefined. This chapter seeks to understand what our future workspaces might look like.

Fig. [3.15]: In September 2020, Network City and Landscape, from the Department of Architecture at ETH, published an article on working from home and its consequences. Among the various social, economic and environmental consequences, the impact on real estate is highlighted, showing how the new hybrid way of working has ultimately left office spaces completely empty.

Status Quo

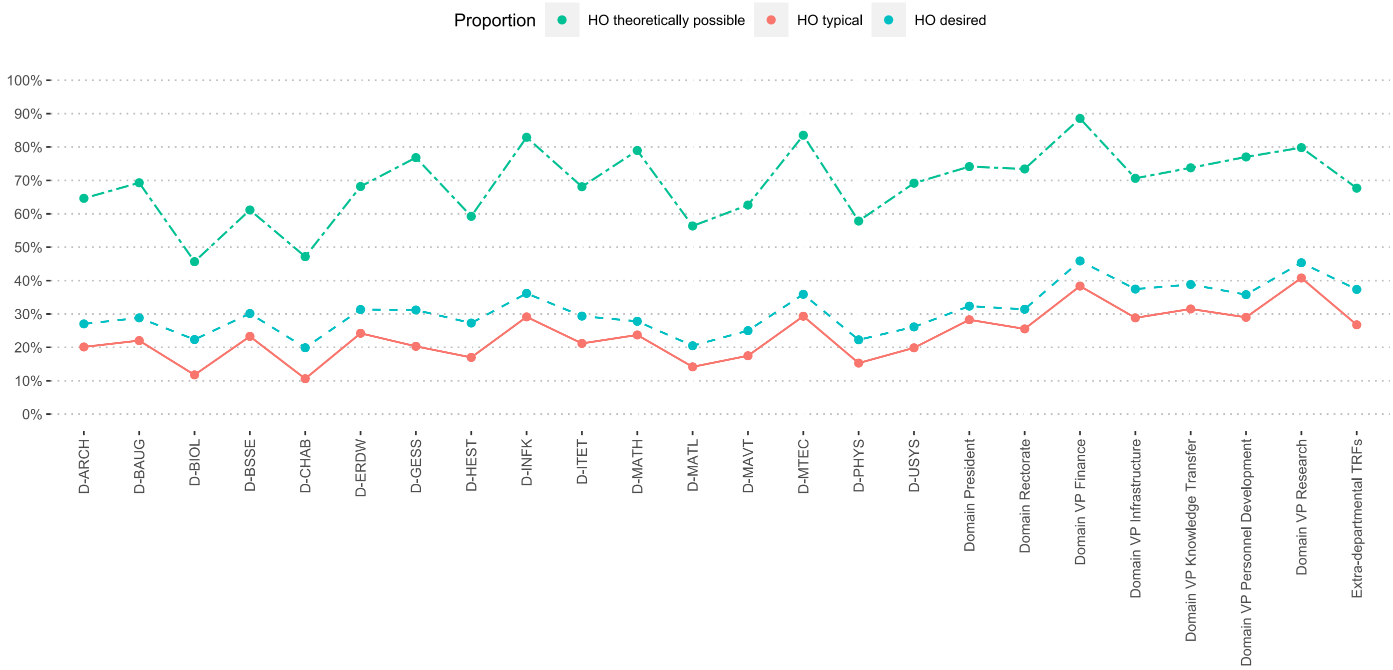


Fig. [3.16]: The Future of Work Survey enabled us to compare the home-office situation between the different departments and domains. The flexibility allowed by the different types of activity is seen through the analysis of the current percentage, the desired percentage and the theoretically possible percentage of home-office.

Future of Work Survey
During the pandemic, many changes took place in the way we worked, the place we worked at and the tools we worked with, and those changes are now here to stay, at least some of the time. The "Future of Work survey", conducted by ETH Zürich in November 2022, gave ETH employees the opportunity to give feedback on their experiences and preferences regarding the new, flexible way of working at ETH. It also gives an impression on how work and its new forms are intended to be shaped at ETH in the future.

At the time of the survey about half of people had adopted a hybrid way of working. In average employees currently work 25% of their time at home and 63% on-site. This situation might change in the future since the percentage people wished to work in home office is 35% and 56% on-site.

Of course, the situation is different between the different departments and domains, but a clear conclusion can be drawn from the Graph: the executive board domains are keener on home-office than the departments. This is seen through the possible, typical and desired home-office percentage which are each about 10% higher than in the departments. Those differences mostly come from the way the employees engage on their workplace and how they are dependent on it.

Interestingly, the theoretically possible percentage of home-office is much higher than the desired. It is considered that about 2/3 of the tasks could be carried out at home, yet people still wish to work 1/3 of the time in home-office. The advantages of working on site are therefore too great for them to work solely from home. [3.21]

«On average, the potential concern that employees would want to work exclusively from home was unfounded.» [3.22]

ETH's Future of Work Survey

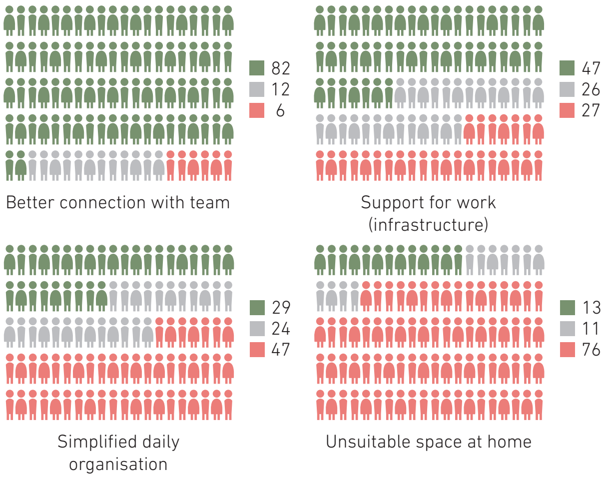


Fig. [3.17]: A selection of on-site working's advantages, as expressed by ETH employees in the Future of Work Survey.

Advantages of working on-site

Thanks to a better connection with the team and improved communication, working on site means that problems can be solved more easily and more quickly. As loss of identification is one of the major problems of home-office, good communication still must be promoted between the home and the office, so as to create a sense of belonging. According to the survey's results, this is of great importance for teachers, for example, but much less so for IT staff.

Work in departments such as Physics, Biology or Chemistry and applied Bioscience takes place in fully equipped laboratories and cannot be carried out at home, making employees highly dependent on their place of work.

Around 70% of employee interactions take place in the same building and 15% take place between different ETH sites or buildings. This spatial connection makes it easier to organize the day on site and saves time.

Although a minority, some people decide to work on site because their home doesn't allow them to work efficiently. To overcome this problem, ETH could intervene in its employees' homes to create an appropriate working environment. [3.23]

Advantages of home-office

Saving time by not having to commute is the biggest advantage of home-office for ETH employees. Intuitively, the reduction in traffic time also leads to a reduction in CO2 emissions and about half of ETH employees see this as an advantage of working at home. Nevertheless, according to an article by Forbes, the situation is more ambiguous. When working from home, car use for non-business purposes might increase. What's more, sales of furniture and electronics increased during the pandemic, as did demand for larger spaces in which to incorporate a workspac at home. Therefore, this duplication of the office space isn't as environmentally friendly as we might think at first glance. [3.24]

Around two-thirds consider that they have a more harmonious work-life balance thanks to home-office. The remaining third, on the other hand, see the blurring of work/life boundaries as a major problem of home office, as it leads to a feeling that work never ends. As these experiences are personal, it's important that everyone has the freedom to create a healthy work situation to suit their needs.

Around 60% decide to work from home to complete tasks without interruption. This allows them to work more efficiently and focused on work that doesn't require collaboration with colleagues. [3.25]

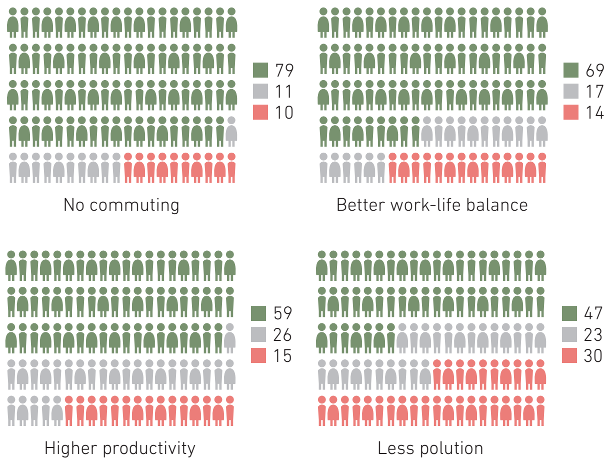


Fig. [3.18]: A selection of home-office advantages, as expressed by ETH employees in the Future of Work Survey.

«What should happen in the office in the future ? Why am I going

Octavo as research space

In 2020, during the pandemic, around 550 employees moved into the new offices in the Octavo building. These offices are characterised by the openness and flexibility of the different spaces, allowing different ways of working. Octavo is currently a kind of laboratory for new ways of working, where concepts such as think tanks, desk-sharing and communication zones are tested and evaluated, before being improved or implemented. Each section has a space dedicated to its employees, called a homebase, but thanks to its open plan and flexible infrastructure, Octavo should also facilitate cross-departmental collaboration. [3.27]

These new offices are designed from inside out, taking the users' needs as starting point. On the other hand, they must also meet the government's requirement to use space more efficiently. Given that the average work percentage at ETH is 90% and the home-office percentage 25%, it can be concluded that offices are empty around a third of the time and, according to a presentation on the Future of Work at ETH by Constanze Weihs, they are even empty more than half the time. [3.28] For this reason, desk-sharing should become standard by 2024. Currently, the desk-sharing ratio in Octavo is good, between 0.5 and 0.7, which means that 10 people use an average of 5 to 7 desks. [3.29]

DESK-SHARING

Fig. [3.19]: Desk-sharing makes the choice of workplace more flexible for employees and reduces the number of desks needed. Each employee can connect his or her personal computer to the screen at the beginning of the day. At the end of the day, he or she disconnects to make room for a colleague the next day.

INFORMAL MEETING AREAS

Fig. [3.20]: With the aim of creating a friendlier and more pleasant working atmosphere, some areas allow employees to get together for a short, informal chat.

THINK-T

there ? What kind of appeal does the location have ?» [3.26]

Constanze Weihs,
Leading Specialist for Workplace consulting at ETH

HYBRID MEETING ROOMS

Fig. [3.21]: Hybrid meeting rooms are designed to encourage collaboration between different working arrangements by enabling a more interactive communication between those on site and those at home or on the go.

TANKS

Fig. [3.22]: Think tanks are used for moments of concentration but also to make zoom or phone calls without disturbing other colleagues. They can be used a maximum of twice a week per employee.

The various spaces created by Octavo are part of a very current trend. Google, among others, has also introduced new spaces and technologies to encourage hybrid working. Office space is made more flexible thanks to movable walls and adaptable air duct system. Some spaces are similar to those at Octavo: hot desks make desk-sharing easier, the campfire serves as a hybrid meeting room, team pods are collaborative spaces that can be quickly rearranged and cells are dedicated to focused work. [3.30] The idea of saving space through new ways of working is therefore an important movement at a global level and ETH guidelines, such as the obligation to have a minimum of 50% group offices and a maximum of 10% cellular offices, shows that the institution is part of it. [3.31]

Fig [3.23]: The courtyard of the Octavo building in Oerlikon.

«We are already using the insights gained from Project Octavo for our next projects, including in teaching and research. If something works, we will keep doing it. If something does not work, we evaluate and improve it.» [3.32]

Ulrich Weidmann,
Vice President for Infrastructure

In 2018, the Executive Board decided to rent the Octavo building, in Oerlikon. Employees from the VPIN and VPPL now work in open multi-space office premises that facilitate new forms of collaboration. [3.33]

WHAT IF?!

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Department of Spatial Politics
Department for the Future

ETH Zurich
Louis Prongué
Workspace Research Manager
ONA G23
Neubrunnenstrasse 50
8050 Zürich, Switzerland

INTERNAL

Zurich, 13 October 2038

Dear ETH colleagues,

After long years of trying to cope with the complex economic and climatic situation, the ETH Board has come up with a solution to the ongoing debate. As of Monday the 5th of September 2039, the 1/5 model will be implemented, meaning all ETH employees will be allowed to work on site a maximum of 1 day a week. Although ETH has always been trying to foster on-site presence, it was decided that, as a technical university, ETH must pave the way for the future and serve as example.

The 1/5 model will greatly reduce commuting traffic and space consumption. In labs and in archives, the work will gradually be replaced by robots monitored from home 4 days a week with 1 day on site foreseen for maintenance. Communication between the ETH offices and your home will happen through Teams and Zoom.

The team for Rooms of Excellence at the Department for the Future will assist you in creating a healthy and productive home-office space, financially and strategically. On the energetic side, it was decided by the ETH Board that 50% of the energy consumption at home will be covered by the ETH itself, mainly with the excess of the Anergienetz and additionally through financial compensation. Lastly, due to the rise of depression caused by home-office, the Mental Health Group was created by ETH and will offer free consultation on Zoom.

If you have any questions concerning mental health, financial compensation or technical issues don't hesitate to contact us and we'll be pleased to help you in this extraordinary situation.

Yours sincerely,

Department for the Future

Louis Prongué
Workspace Research Manager

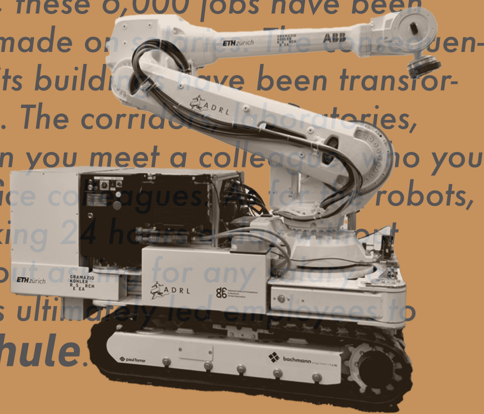
Tim Moosbrugger
Analyst of space use and innovative programs

1/5
day on site

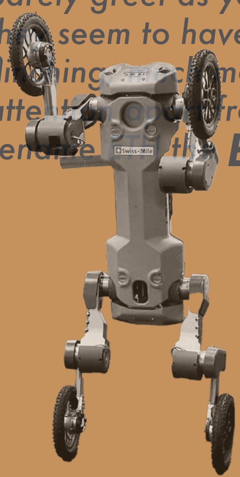
74%
depression

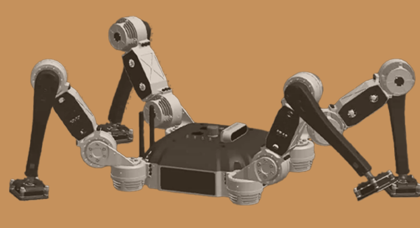
6.000
jobs replaced by robots

ETH developed robots



The surface area used by ETH has been divided by 5 thanks to the 1/5 model, costs have been drastically reduced thanks to the dismissal of 6,000 employees but 3 out of 4 employees are now suffering from depression. For good reason, these 6,000 jobs have been replaced by around 6,000 robots financed by the savings made on salaries. The consequences of the 13 October letter are immense. The campus and its buildings have been transformed into a ghost town, as if people had vanished overnight. The corridors, laboratories, meeting rooms, offices are all empty but every now and then you meet a colleague who you barely greet as you no longer know each other as home-office colleagues. As for the robots, they seem to have taken up residence in the buildings, working 24 hours a day without flinching, much more efficient than a human being and without asking for any salary or attention apart from the occasional repair. This situation has ultimately led employees to rename ETH the ***Ehemalige Traumhafte Hochschule****.*





Status Futura

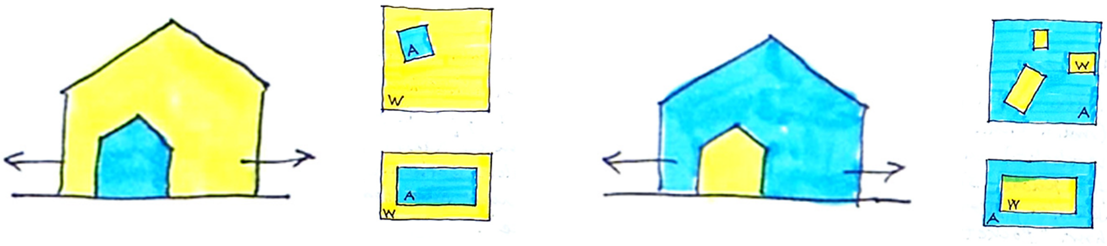


Fig. [3.24]: Sketches by ETH Professor Andrea Deplazes from the lectures of the HS21 sememester *"Zur Dialektik von Wohnen und Arbeiten"*. *Wohnen* in yellow and *arbeiten* in blue are in this case integrated in each other.

In 1989, the urban sociologist Ray Oldenburg published the book "The Great Good Place". He suggests that, to lead a happy life, citizens need to find a balance between three realms: home-life, the workplace and inclusive social places. Cafés, bookstores, bars, hair salons and churches are typical of this third realm, which he also calls the third place. [3.34] This third place is an essential element in the life of any community, because it allows people to put aside the worries of home and work, the first and second places. The pandemic disrupted this hierarchy by bringing the three realms together in one space, the home-office, and although the third place has returned to its original location, this is not the case for the second place. [3.35]

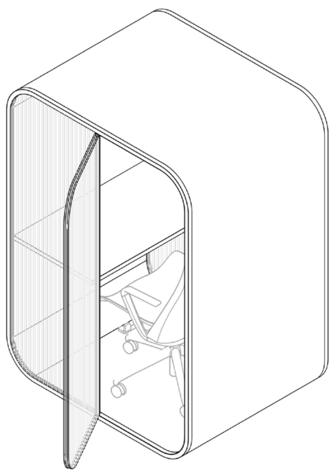


Fig. [3.25]: HOM by Atelier Marko Brajovic, 2020.

The home-office
What used to be the first place is now taking on a new function and must adapt to it. For many people, home-office allows uninterrupted work on tasks that do not require collaboration with other colleagues, meaning that their workplace at home must reduce distractions. This represents a social and spatial challenge, as family life is complex to combine with work. Atelier Marko Brajovic has come up with a relatively extreme but very telling solution in its HOM project, as they created a capsule for focused work where one can be completely isolated from family life. [3.36] Other solutions were found during the pandemic, the lucky ones had a room that they could transform into an office but otherwise spaces had to be adapted.

In this quest for the ideal home-office, ETH may have an important role to play in the future. At the moment, ETH provides documentation in terms of ergonomics and data protection and uses its existing telematic resources for the home-office. In the future, more concrete financial and strategic support could make remote working an attractive arrangement for everyone.

Even if the desired percentage of home-office at ETH is only 35% [3.37], there is a chance that it will increase in the future. With this in mind, ETH could create Richtlinien, as they already exist for ETH spaces, but dedicated to home-office. Different office layouts could be proposed depending on the rooms and the space available, along with a guide to adapting different rooms in the home into an office for excellence.

The office-home
After the pandemic, the return to the office phase has not been as successful as expected, leading some companies such as Google to tighten up their home-office rules. [3.38] Apart from the current trends as presented at Octavo, attempts are being made to repopularise the office, for instance by creating an office-home.

The idea of the office-home is merely to integrate the first and third place into the second. During the day, you can play table tennis in the office, have a coffee at a coffee stand, go to the gym just a few meters away from your workplace, etc. The office can also be used at the end of the working day. The room can be transformed to accomodate an aperitif or dinner with colleagues and film evenings can be organised thanks to the on-site facilities. Nevertheless, the idea of the office-home represents a great danger, that of never leaving the office. [3.39]

Empty offices are a worlwide problems. In New York, the value of all office properties fell by 40% in 2020 and is expected to remain at these levels in the future. [3.40] In this context, a former Daily News office is being transformed into an apartment building in Lower Manhattan, symbolising in a way the apogee of the office-home, where the second place has been replaced by the first place. [3.41]

The new (so)ci(e)ty

New ways of working are also having an impact on the city on a much larger scale. This is shown by studies in the USA, which have found that home office is changing the relationship between the suburbs and the city. This change is leading to a new urban model, the hub and spoke model. Instead large office buildings in the city centre, in this model a single office building is located in the city centre and several offices are located in residential areas. This reduces employees' commuting time by providing them with a rapidly accessible working place. Obviously this migration has an economic consequence, with prices and rents rising in the suburbs, while the opposite trend is occurring in the cities. [3.42] On the other hand, work has recently tended to move to the third place too. It's not unusual to see people working in a café or a library in city centers, so the office is also moving into the city, but in a dispersed way.

Of course, change doesn't just happen in space, it also has to happen in people's minds. Desk-sharing, for example, requires a certain amount of adaptation, as the office no longer belongs to a single employee but is shared between many, which is a certain social challenge.

Another social challenge of home-office is gender inequality. A Guardian study showed that women have traditionally submitted more home-office request than men and, as a consequence of not being on-site, have seen there responsibilities be reduced and the relation to their manager deteriorated. [3.43] However, in Switzerland, according to an article by the Federal Statistical Office, men and women both work remotely approximately 12% of the time. In fact, women even spend more time in their offices (78%) than men (65%). Therefore, in Switzerland, the risk of home-office creating greater gender inequality is relatively small. [3.44] Nevertheless, it is the responsibility of the manager to create an environment of equality for all the employees.

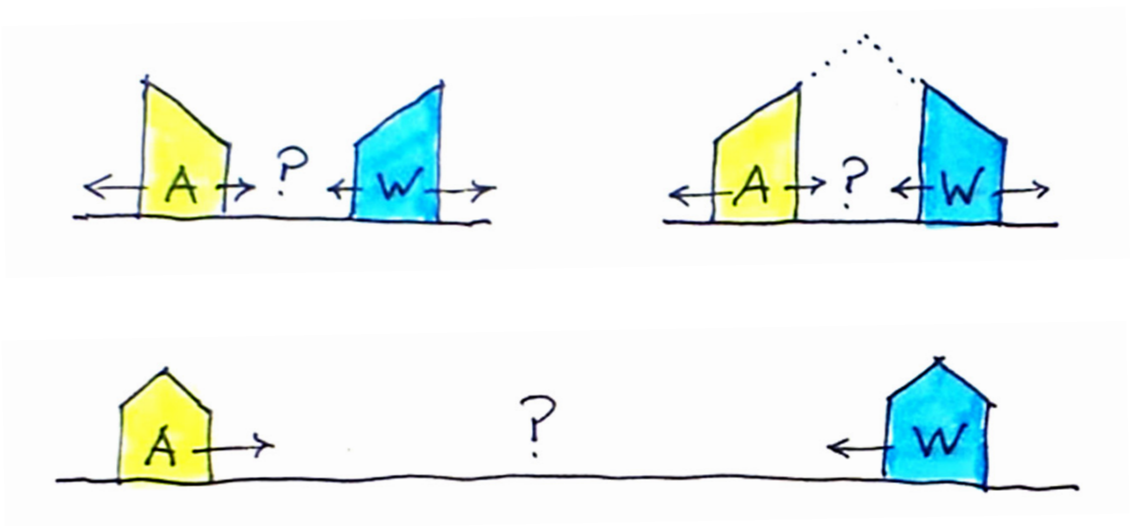


Fig. [3.26]: Sketches by ETH Professor Andrea Deplazes from the lectures of the HS21 sememester *"Zur Dialektik von Wohnen und Arbeiten"*. *Wohnen* in blue and *arbeiten* in yellow are in this case independent but what happens in the space in-between ? Commuting ?

ETH wants to get rid of its student accomodations and create a Stadtquartier by introducing cafes, restaurants and shops on the buildings' ground floors.

Real Estate Department

Are cafes, restaurants and shops really enough to create a Stadtquartier ? Wouldn't it need living to create a vibrant campus outside teaching hours ?

Department for the Future

The UniverCity

The concept of the UniverCity is not new; cities such as Cambridge have managed to integrate the campus into the city over time and have created a symbiosis between the two entities. [3.45] Similarly, ETH developed in the centre of Zurich until the early 1960s, when certain departments moved to Hönggerberg, as described in the section "Past and current Visions for Campus Hönggerberg". Despite the public transport that connects Hönggerberg to the city, the Campus remains, in terms of its functions, only a University Campus and does not yet have the hoped-for status of a Stadtquartier. But why does a university seek to integrate the city into its campus in the first place ? Is it simply a marketing tool, or are there real advantages to blending the university with the city ?

During the FS23 semester at ETH, a group of students organised a Wahlfach called "unmasking space". The idea of the Wahlfach was to show that the western-influenced curriculum for architecture is out of date with the current situation, particularly with regard to issues such as racism and gender equality. Architecture is seen as an elitist profession that serves a system based on social inequalities, and the curriculum itself can be seen as an instrument created to preserve the status quo. [3.46] As a solution, a short video by Panta Rhei Collaborative presented during one of the courses proposes that we allow the city to become our university. In this way, we can distance ourselves from the university and let the real world, the city, inspire us to make and learn architecture that is in tune with its time. [3.47]

With the idea of turning Höngg into a Stadtquartier, the "Sonderbauvorschriften ETH Zürich, Campus Hönggerberg" define several buildings that include "publikumsorientierte Erdgeschossnutzungen" along both the main and secondary axes. [3.48] The idea is for these functions to be used by students and employees working on the campus, but also by people from outside the campus, from the city.

Fig. [3.27]: Masterplan Campus Hönggerberg 2040, main and secondary axis with public-orientated uses in dark orange.

But once the day is over, and the students and employees have gone home, would the campus still be full of life ? To create a symbiosis between the city and the campus, one could integrate living into the campus. Not living for students and employees who represent the institution, but living for people who work elsewhere, people who represent the city. In this way, the university would be more directly confronted with the reality of the city, as advocated by the Panta Rhei Collaborative, and ETH Hönggerberg could become a true UniverCity.

Conclusion

The expansion phase in which ETH currently finds itself presents many challenges which require the institution to change and adapt. In the current climatic situation, ETH, as a world-renowned university, must set an example and promote environmentally responsible use of space.

To this end, the 7th Principle of ETH's Real Estate Strategy - "consolidating the uses and increasing the density of existing buildings" - must be applied more rigorously. At the moment, offices are still empty 50% of the time [3.28] and teaching rooms are used only 37% of the year on average [3.15]. The few solutions found to address these problems come from independent actors within the institution operating on a small scale, not from the institution itself. Jan de Vylder's Ours/Yours Office, HCI's Hidden Pub and events like the PolyLAN are current answers serving as examples for a more diversified use of our workspaces.

The vacancy observed at ETH has been bolstered by the new hybrid way of working and studying, introduced during the pandemic. A decentralisation of the work- and studyspace has taken place, requiring new means of communication such as the Metaverse. The encouraging results of the first learning tests using this new technology suggest that it is an ever closer reality. Our homes and workspaces will have to adapt to it and become hybrid, but the adaptation will also have to occur in people's minds. An office on-site is no longer assigned to one person in particular, but must be shared by several. On the other hand, the frontal format of lectures needs to be rethought and promote interactive learning between students even more. This communication may also be taking place in a virtual reality, other than that of the institution.

The 7th principle must therefore have priority over the construction of new buildings. In order to fulfil the full potential of the existing portfolio, the question to be asked is no longer "What do we need ?" but "What do we already have ?" However, it is clear that ETH will continue to build, so the challenge arises as to how we avoid repeating the mistakes we are currently encountering; namely not clustered vacant spaces but their distribution among the whole building stock. The repurposing of future buildings, their rooms and their functions must already be part of the planning process. In times of rapidly changing circumstances, they need be able to host different futures.

The boundaries between working/studying and living are blurring, so what is the future for our rooms and how are the rooms for the future defined?

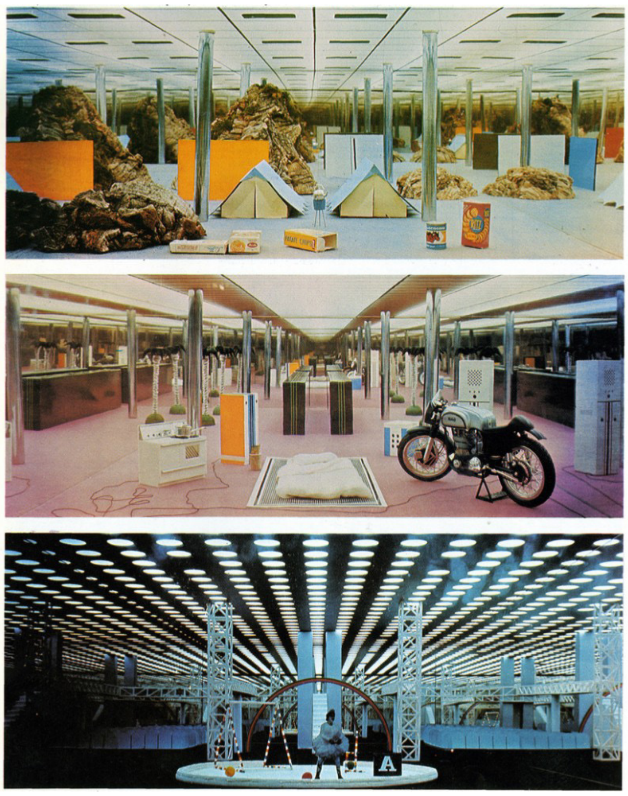
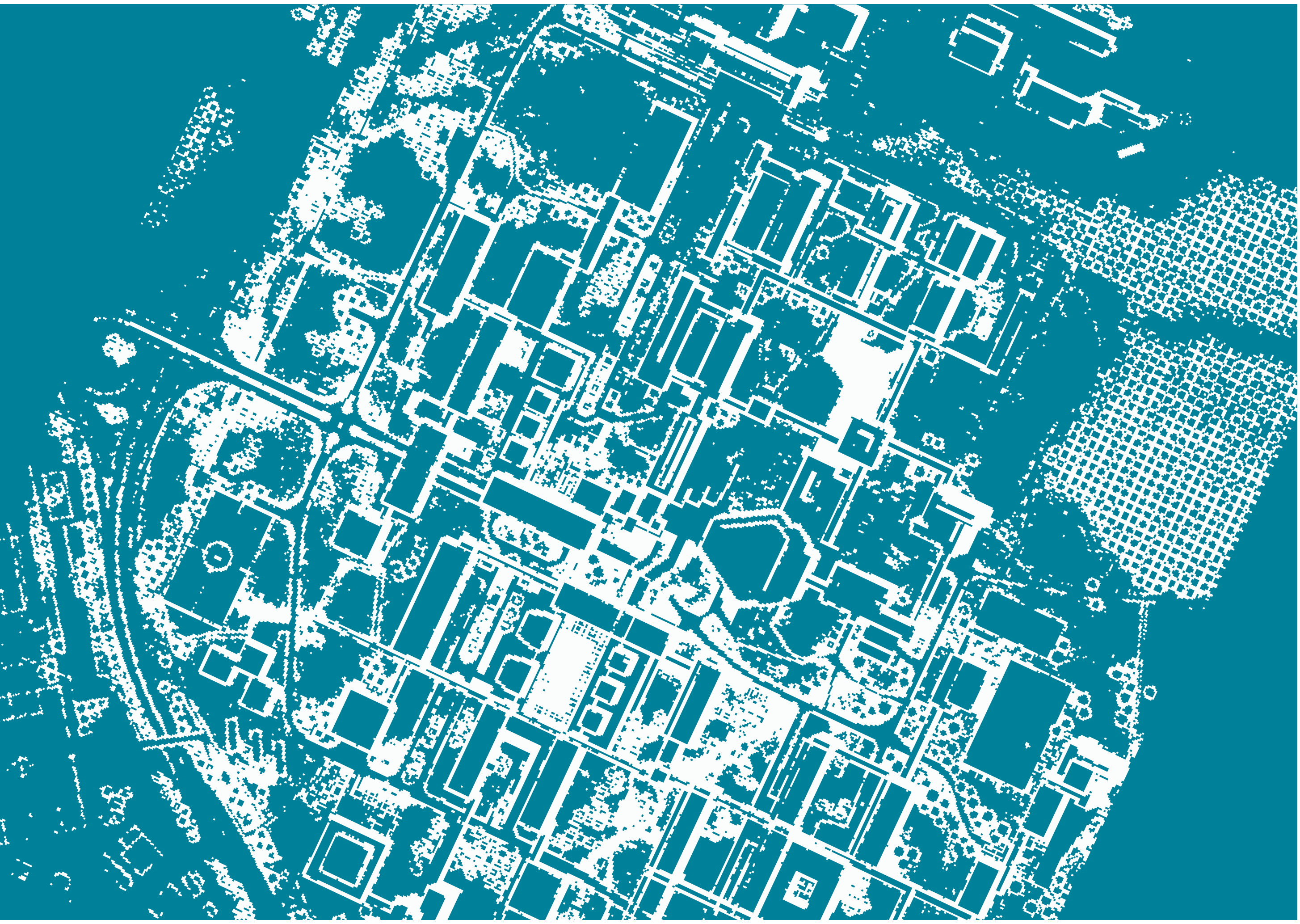


Fig. [3.28]: No-stop city is a project by the Archizoom design studio. Conceived in the early 1970s, the project consists of an infinitely expendable grid that can be used for a variety of purposes, allowing us to be anyone, anywhere.

Past and current Visions for Campus Hönggerberg

Since the decision to establish an ETH satellite campus on Hönggerberg, there have been various master plans. This Chapter seeks to explore the various kinds of traces, left behind by these plans over the past 60 years.



Introduction

The master plan is an important instrument when it comes to the long-term development of an area or a district. In it, various visions for the future are negotiated and finally incorporated. But the master plan is only a proposal, what comes out of it depends on the circumstances.
In this analysis, the goal is to find out what traces previous master plans for the Hönggerberg have left behind, using the example of the ETH Hönggerberg campus.

The selection was made after research and tries to analyze the most formative projects. It has to be said that the selection was also influenced by the access and the own perception. Thus, it follows that it is not a complete but at most a representative selection.

Masterpläne:

- 1961 A. Steiner
- 1970 A. Steiner
- 1989 Wäschle Wüest
- 2005 KCAP
- 2015 EM2N

After selecting the plans, the next step was to select the traces. Here, too, I had to weigh up which trace would ultimately help me the most to clarify the questions. Although there are countless other aspects such as the volumetrics or boundaries/ edges I think the following traces are the most informative.

Traces:

- Composition
- translation
- Free/Green-Spaces
- Mobility
- Atmosphere

During the research there were several questions that came to the fore. Why have the master plans, which are designed for several decades, been redone much earlier? Why does every planner feel the need to start all over again? Is this really new? What remains of the individual plans? These questions will now be addressed in the following section.

Bebauungsplan A.H. Steiner, 1961

After the Federal Council approved the expansion of ETH on Hönggerberg, A.H. Steiner was tasked with creating an initial development plan. This plan was presented to the National Assembly in 1961 for the approval of a credit of 38 million.

Fig. [4.1]: In the composition there are diverse building typologies, organized along a central axis in an orthogonal system. Open spaces are a crucial element of A.H. Steiner's design, creating a structured layout.

Fig. [4.2]: Opposite Page

Analysis

History

To appreciate the development of this plan fully, it is crucial to delve into the historical context of how the Campus Hönggerberg project came into existence. A century after the establishment of ETH, the Zentrum faced big challenges for expansion, despite its continuous growth. Following site visits and a thorough examination by the Federal Council, the decision was made in 1957 to designate Hönggerberg as the future external site for ETH Zurich. Two years later, a planning group was formed within ETH, which counted among its members a prominent city planner, A.H. Steiner, together they created a proposal. This proposal was presented to the Federal Assembly in 1961, resulting in the allocation of an initial budget of 38 million Swiss francs. In the same year, a project plan was formulated, marking the commencement of construction for the physics buildings. The significance of this plan, though only partially realized in physical form, lays the critical groundwork for the ongoing evolution of the campus. Of importance is the central role accorded to open spaces and their harmonious integration with the natural surroundings. Even today, a visit to the Albert Steiner Garden provides connection to the importance of outdoor areas. This connection between built and open spaces also encompasses the visual relationships, which constitute another pivotal aspect of the plan and continue to influence subsequent phases of development. [4.1,4.2]

Composition

The composition offers a fascinating glimpse into the campus's layout, showcasing a diverse array of typologies with varying levels of intricacy sprawled across the site. The core of this arrangement is anchored around a well-defined central axis with substantial interstitial spaces. All buildings and open areas adhere to an orthogonal system along this axis, introducing an element of order and structure into what might otherwise appear as a freeform arrangement. Notably, the open spaces are central to A.H. Steiner's planning, underlining their integral role in the overall design.


AFFOLTE
8
7
1
KA
3
4
2
6
8

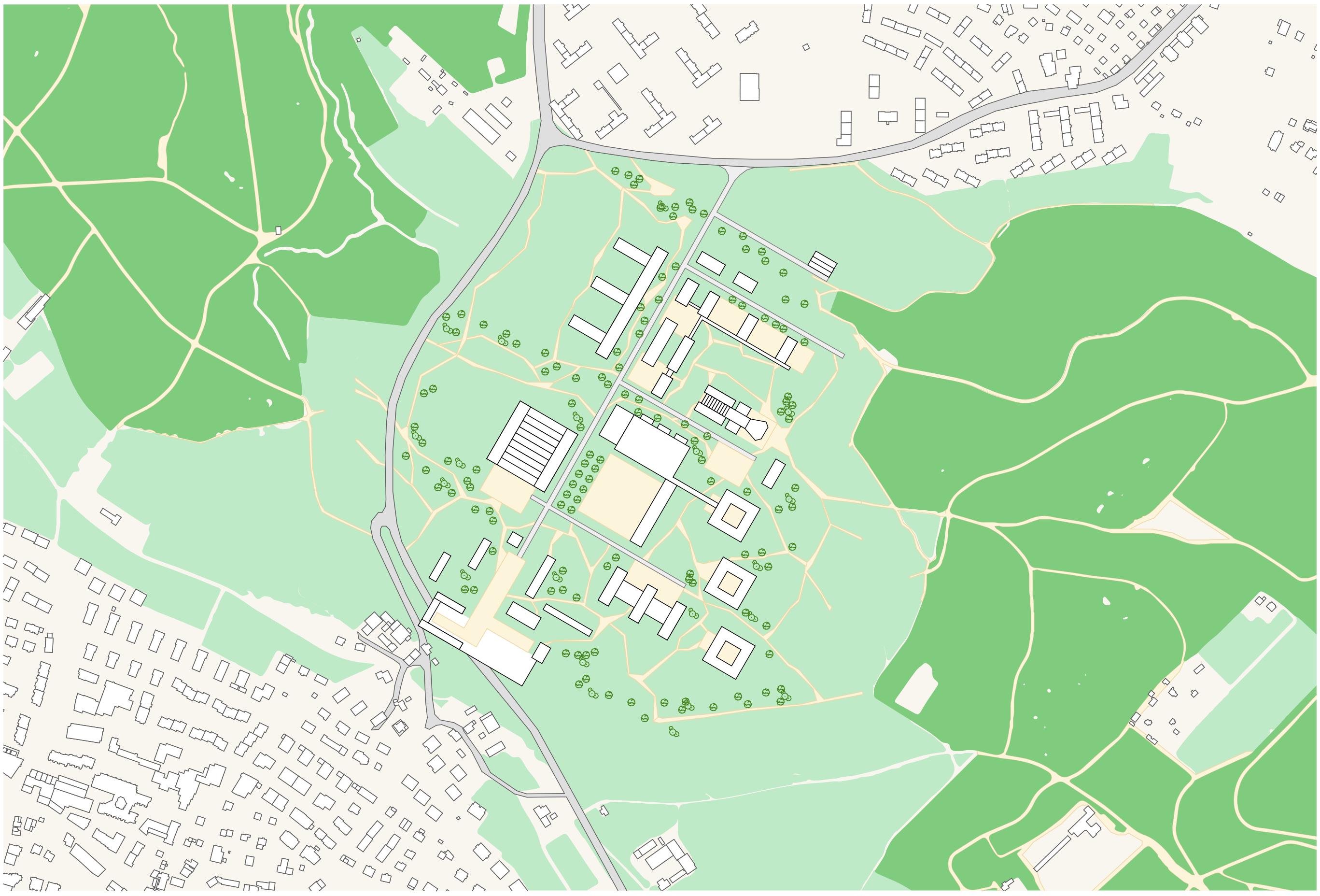


Fig. [4.3]: The planned campus aims to create a generous, nature-connected atmosphere through diverse building sizes and shapes, providing a modern and adaptable vision for Zurich in the 1960s and beyond.

Mobility

Unfortunately, the traffic situation is not completely clear in this plan; with the help of other sources, it is assumed that the arrival for both MIT and public transport is planned in the underground of the reception building at the southern end of the site. The underpass of the road is also reminiscent of a similar situation at the Polyterrasse. This special approach makes it possible to make the area car-free. In addition to the large connecting axes, a very fine pedestrian network is also planned. This connects the buildings on the site as well as the neighborhoods and the forest in the immediate vicinity.

Atmosphere

The envisioned atmosphere for the campus is one of expansive openness, intrinsically linked to the natural environment. The deliberate diversity in the size and shape of the buildings and open spaces is a testament to the foresight in the planning process, preventing any semblance of monotony even at a considerable scale. Notably, this visionary planning was exceptionally modern for Zurich in the 1960s, bearing the hallmarks of a forward-thinking approach that aimed to be adaptable for the future. This adaptability extends to the resurrection of the concept of high-rise buildings on the Hönggerberg in subsequent planning endeavors.

Fig. [4.4]: The plan proposes underground arrivals for both MIT and public transport, resembling a car-free model like Polyterrasse, with a fine pedestrian network connecting buildings and the surrounding areas.

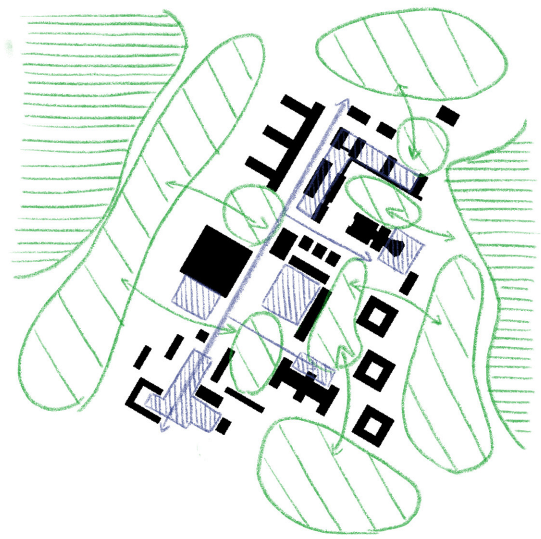


Fig. [4.5]: Open spaces and green areas are central to the planning of the site, creating a very open and nature connected campus.

Free/Green-Spaces

While only a fraction of this comprehensive development plan have been realized, it serves as the cornerstone upon which the future of the campus will be built. A paramount element of this foundation is the integral role accorded to open spaces and their harmonious integration with the surrounding natural landscape. Even today, stepping into the Albert Steiner Garden evokes a tangible connection to the enduring significance of outdoor spaces. This interplay between built and open spaces isn't solely confined to physical design but extends to the concept of visual relationships, a pivotal component that found resonance in later phases of development.

As we reflect upon the unique character of the planned campus, it becomes evident that it aspired to transcend the confines of mere functionality, seeking to create an ambiance where students and faculty could thrive in an environment that harmoniously blends the academic and natural worlds. The introduction of diversity in both architecture and open spaces not only adds visual interest but also invites a sense of exploration, where each building and green expanse tells its own story within the larger narrative of the campus.

Conclusion

The foresight demonstrated in this modern 1960s planning is particularly noteworthy. It reveals a commitment to long-term sustainability and adaptability, a testament to the architects' vision of how the campus would evolve over the years. Even though not every aspect of the plan was physically realized, the foundational principles it laid down remain instrumental in guiding future development.

In conclusion, while the full realization of the development plan remained a work in progress, the enduring influence of its principles is evident in the evolving campus landscape. It continues to serve as an invaluable blueprint for creating an environment that seamlessly integrates nature, architecture and academia. [4.3]

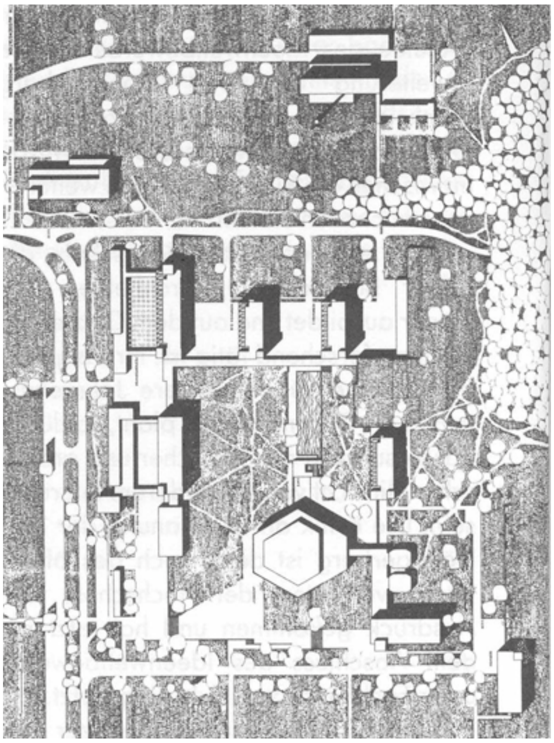


Fig. [4.6]: The part of the plan that was effectively implemented still influences the campus today and remains one of the few areas where green spaces are still present.

Erweiterung Aussenstandort Hönggerberg - A.H. Steiner, 1970

Already during the construction of the physics buildings ETH developed a new Masterplan without Steiner. This second attempt by A.H. Steiner was a reaction to show how his Masterplan from 1961 should be continued.

Fig. [4.7]: In the updated plan, A.H. Steiner achieves a more balanced campus by evenly distributing diverse building types and emphasizing integration, allowing for a cohesive environment.

Fig. [4.8]: Opposite Page

Analysis

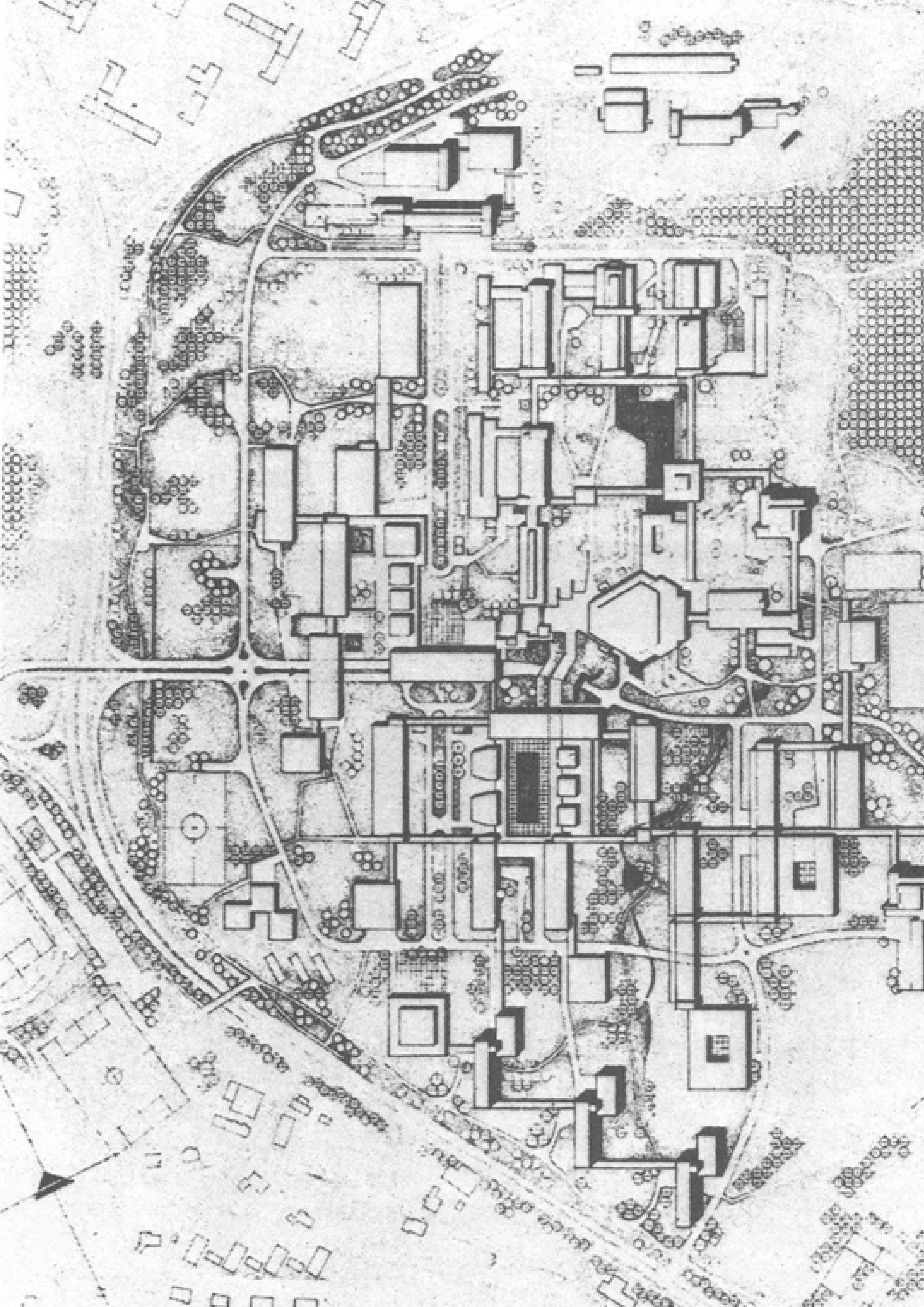
History

A.H. Steiner developed his second plan around 1970 because he wasn't satisfied with ETH Zurich's new extension plan. He believed that it posed a challenge to his existing ideas, and he wanted to convey to ETH the importance of maintaining a consistent concept rather than starting from scratch. Being a professor at ETH with significant contributions to the campus, he felt justified in his criticism. However, ETH's leadership and the ETH Council rejected his concerns and master plan, which unfortunately went unrealized. A significant factor was the limited budget available to ETH at the time, as a new ETH law had been rejected in a student referendum. This constraint hindered long-term planning and resulted in a lack of unified vision until the 1990s.

During this period, buildings like HIL and the Depot Library were constructed, deviating from A.H. Steiner's original concept. The clash of visions escalated to the point where Steiner, in an extraordinary move, took his proposal for the Depot Library to the Federal Court, offering ETH one million Swiss francs to push his vision through. This marked a important moment in the campus's history where contrasting visions and budget constraints led to divergent architectural trajectories that continue to influence the campus's character today. [4.3]

Composition

In the updated version of A.H. Steiner's master plan, there's a noticeable improvement. While the diversity in building types is still present, it's distributed more evenly, making the campus feel more balanced. The previously prominent main pathways have taken a back seat, and there's a greater focus on diverse views and how everything fits together. This approach allows the main buildings to blend more seamlessly with the rest of the campus, creating a cohesive environment.



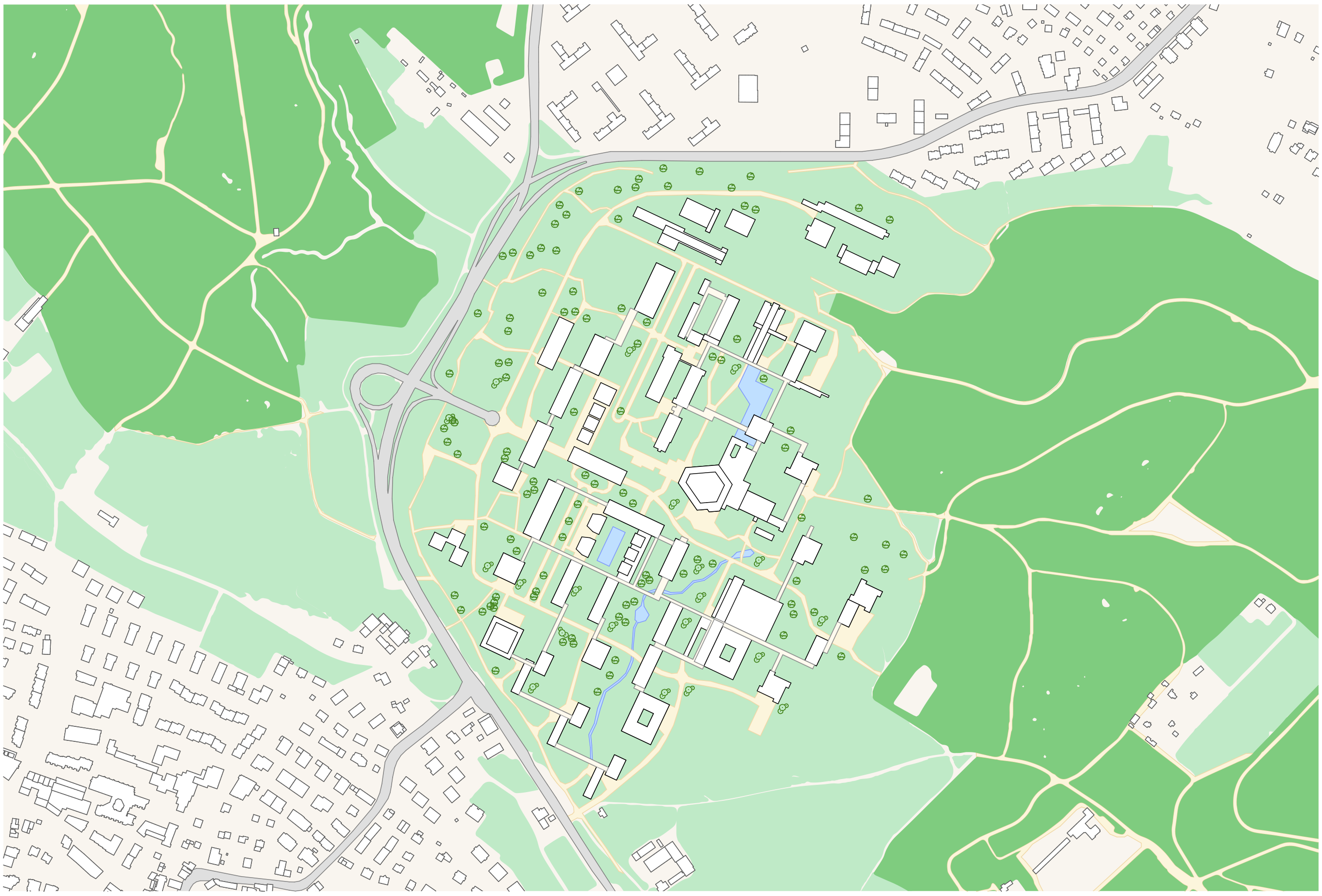


Fig. [4.9]: The architecture's harmonious integration with nature and meticulous planning give the campus a visually appealing, naturally evolved atmosphere that enriches the lives of its occupants.

Mobility

In this master plan, the resolute commitment to maintaining a car-free campus remains a defining feature, emphasizing the intention to create a clean and pedestrian-friendly environment. The exclusive means of access for motor vehicles to the area is meticulously planned through an entrance from the bypass road, leading directly to an underground garage. This strategic choice not only reduces traffic congestion and environmental impact within the campus but also fosters a serene and welcoming atmosphere for all its inhabitants.

Public transportation services are seamlessly integrated, with a dedicated station thoughtfully incorporated within the campus. This well-considered placement ensures that students, faculty, and visitors can access the area with convenience, further reducing the reliance on personal vehicles and promoting sustainable modes of transportation.

The intricate network of pedestrian pathways within the campus is thoughtfully designed to provide easy access to outdoor areas. Prioritizing walkability and green spaces, the plan encourages a healthier lifestyle and fosters meaningful interactions with the natural environment. These pedestrian pathways create a vibrant and inspiring environment for learning and collaboration, nurturing a sense of well-being.

Fig. [4.10]: This master plan maintains a car-free campus, with vehicle access through an entrance connected to an underground garage, and public transportation integrated with a station on the campus.

Fig. [4.10]: Green spaces are a strong focus in this plan, seamlessly integrating the surrounding forest and adjacent meadows into the campus and creating diverse open areas, ranging from urban squares to small garden

Free/Green-Spaces

The spotlight on green spaces within the master plan underscores the profound understanding of the importance of nature in an academic setting. The surrounding forest and adjacent meadows blend seamlessly with the campus, creating harmonious transitions that underline the coexistence between the academic enclave and its natural surroundings. The open areas within the campus are designed with purposeful diversity, encompassing vibrant urban plazas and intimate, peaceful gardens. These open spaces serve not only an aesthetic purpose but also as venues for relaxation, social gatherings, and spontaneous creativity. Moreover, the plan emphasizes maintaining diverse sightlines, not only to connect the neighborhoods of Affoltern and Höngg but also to establish an unbroken visual connection with nature. The holistic design ensures that wherever one stands within the campus, there's a seamless connection to the outside world. This approach fosters a strong sense of place and a profound connection to the broader environment.

Atmosphere

The architecture, in its seamless interaction with nature and open spaces, fosters a sense of harmony and coexistence with the environment. The consistent and meticulous planning lends a uniform and visually appealing character to the campus, creating an atmosphere that feels naturally evolved over time. This quality ensures that the campus serves not only as an educational institution but also as a living environment that enriches the lives of its occupants.

Conclusion

Though the master plan was never fully realized, its enduring legacy continues to provide valuable insights into questions that persistently shape the development of ETH today. These questions involve the integration of a modern academic enclave into an existing city and its ongoing development. The contemporary relevance of incorporating open spaces and green areas into urban planning remains a critical concern, further underscoring the wisdom of a coherent, adaptable, and long-term planning approach. In the pursuit of creating a thriving academic community, these principles remain as relevant and compelling as ever, guiding ETH's evolution and ensuring its continued integration with the surrounding city while preserving the harmony with the natural world. [4.4]

Fig. [4.11]: The architecture, in harmony with nature and open spaces, creates a natural impression through consistent planning, resulting in a cohesive and visually uniform atmosphere that evokes a sense of organic development.

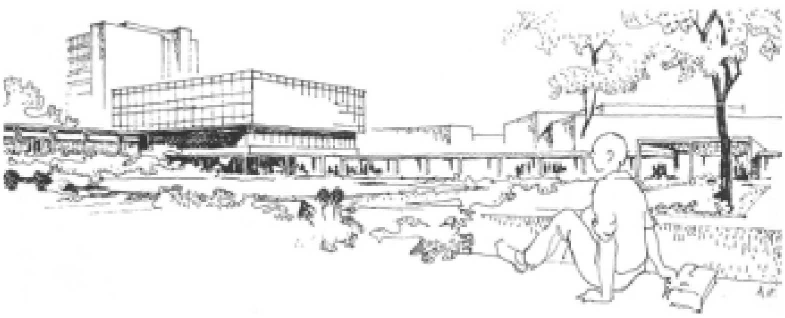


Fig. [4.12]: Sketch A.H. Steiner

Competition entry for the new Campus - Wäschle&Wüest, 1989

As part of the "Academic Vision 2001" report, it became clear that ETH needed new facilities for further growth. Subsequently, a design competition for a campus master plan was initiated.

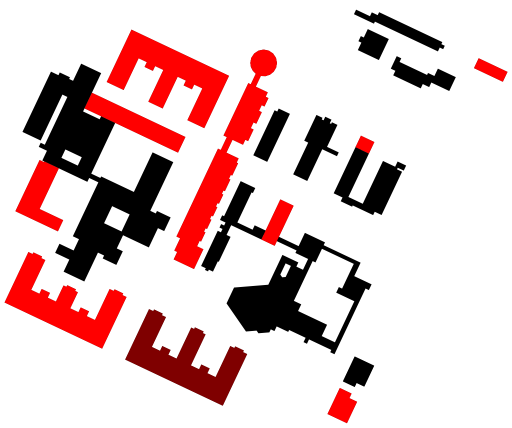


Fig. [4.13]: The new master plan deviates from A.H. Steiner's nature-integrated vision, opting for a contrasting approach characterized by big buildings that establish clear boundaries, emphasizing internal density and geometric precision.

Fig. [4.14]:

Analysis

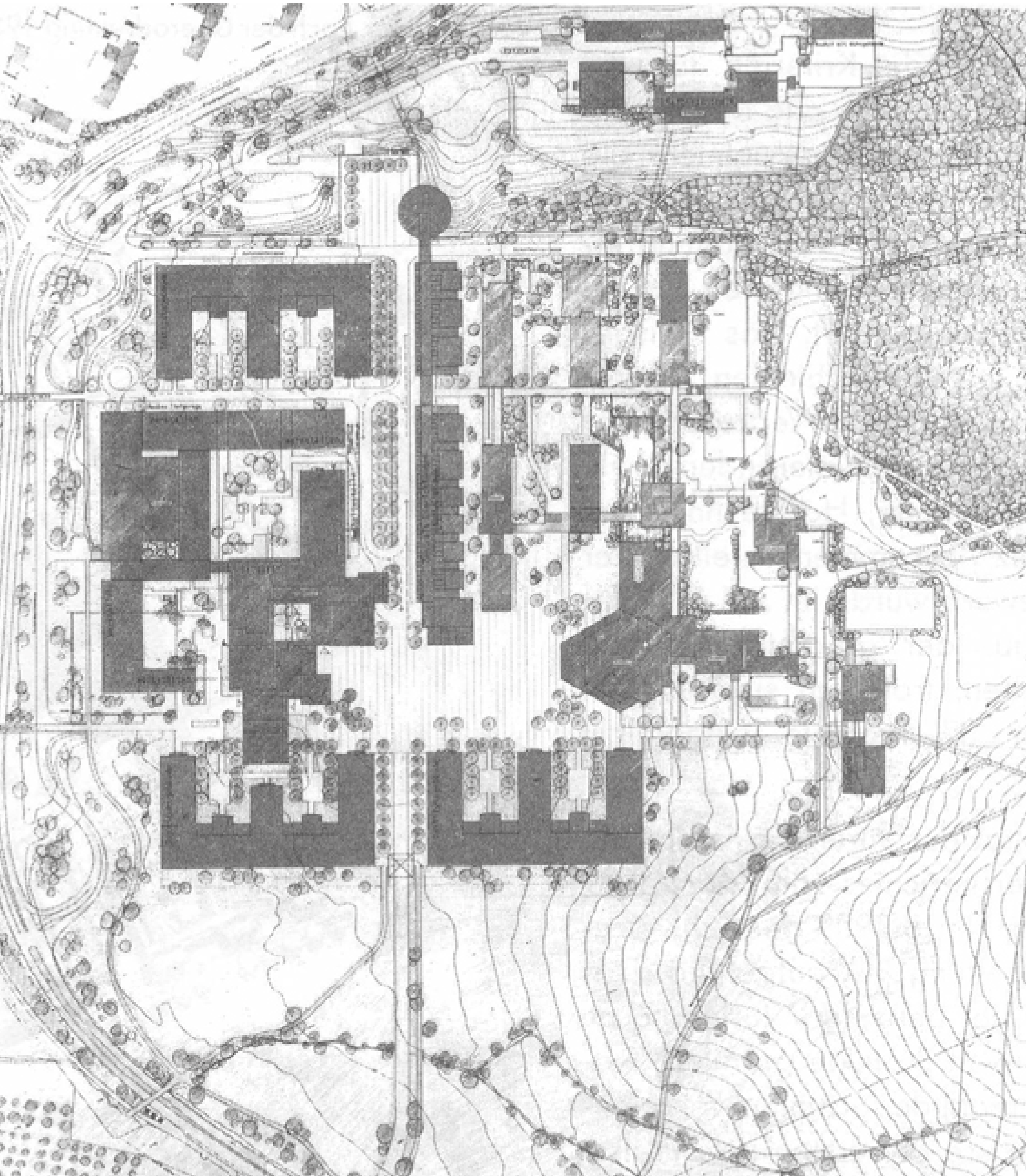
History

The necessity for expanding the Hönggerberg campus had been acknowledged for some time. It was not until the "Academic Vision 2001" that the imperative for additional space to accommodate ETH's continued expansion became clear. Subsequently, a concerted effort was made to craft a new master plan. In 1986, Planconsult was entrusted with a planning study that eventually led to an ideas competition in the subsequent year.

While this competition may not have delivered a definitive solution, it did yield valuable insights that would significantly inform the creation of a future master plan. Consequently, three of the firms were tasked with revising their contributions, taking into account the newly gained perspectives and a more detailed spatial program. Following these revisions, the "Hommage" project, conceived by Atelier Wäschle, Wüest, and Partner, emerged as the cornerstone of the master plan, which was subsequently published in 1989. This pivotal document laid the groundwork for the university's evolving landscape, shaping the course of its future development and architectural identity. [4.5,4.6]

Composition

Within the framework of this new master plan, a significant shift in the approach to campus development becomes evident. While A.H. Steiner's vision centered on the seamless integration of the campus with its natural surroundings, the proposed plan takes a starkly contrasting path. It envisions the construction of substantial, often repetitive volumes that exhibit limited integration with the existing structures. These new buildings serve to create clear boundaries, effectively segregating the campus from its external environment while promoting density within. The interior design reflects a purposeful geometric precision, adhering to a strict and ordered layout.



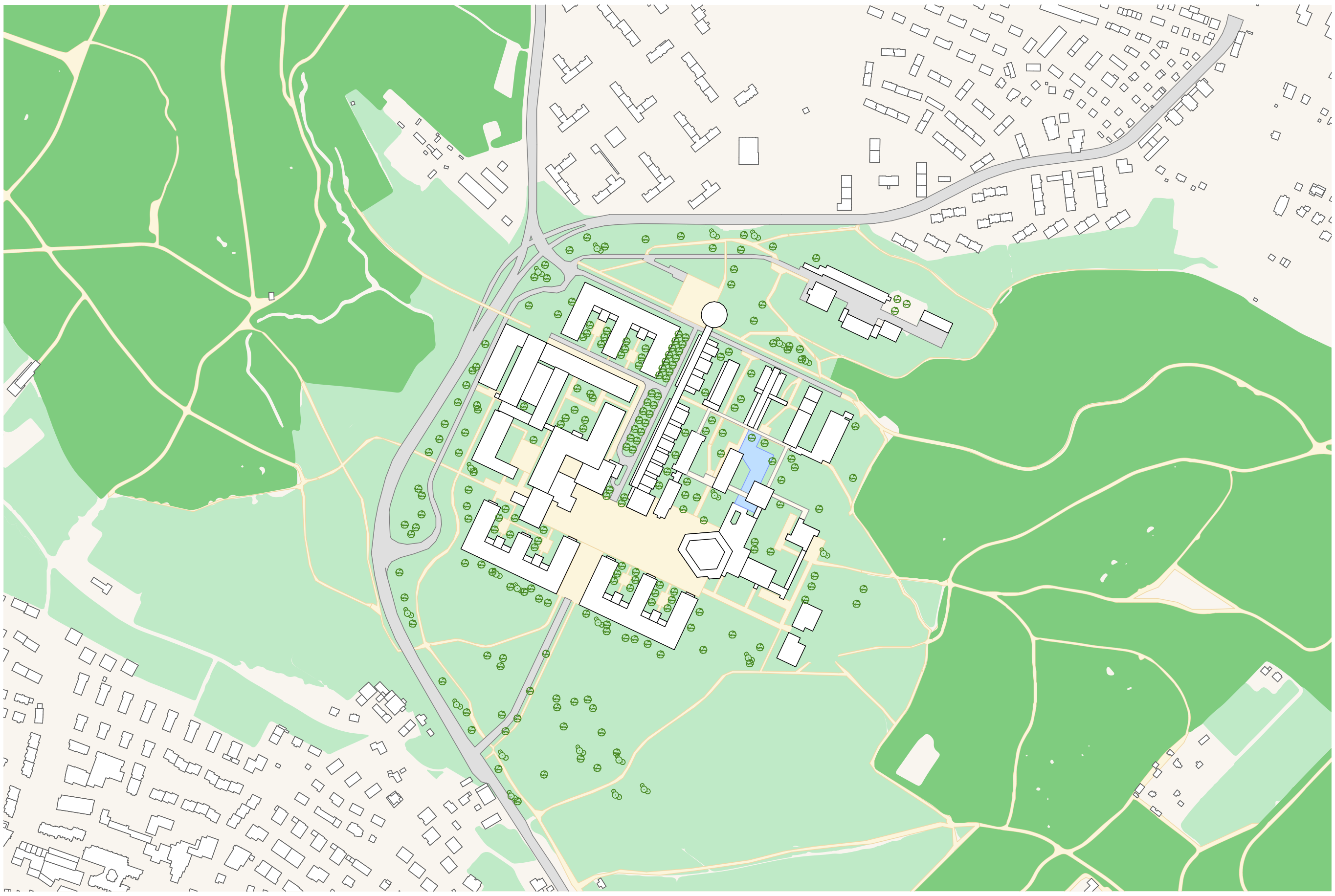


Fig. [4.15]: The new development direction notably alters the campus ambiance, as larger, inward-facing volumes replace the previous open and connected design, resulting in a more enclosed and austere atmosphere.

Mobility

In this master plan, much like its predecessors, motorized individual transport (MIT) continue to be directed from the bypass road into the garage, supplemented with a second entrance in this particular proposal. Public transportation maintains its approach to the campus from the north, ensuring accessibility for those who rely on public transit. Pedestrian pathways have been thoughtfully designed to offer efficient access between buildings, catering to the needs of students, faculty, and visitors. The open spaces surrounding the campus serve as a shared recreational area for both the academic community at ETH and the general public, who can relish the scenic views from the picturesque Hönggerberg.

Atmosphere

This new development direction significantly transforms the overall ambiance of the campus. The introduction of larger, inward-facing volumes creates a sense of enclosure, departing from the previous strong connection with the surrounding environment and cultivating a more rigorous and austere atmosphere. Amidst these substantial architectural changes, one may find themselves experiencing a sense of disorientation in what was once a more open and interconnected campus.

Fig. [4.16]: The Public Transportation gains a new access to the Campus, where its also able to Change direction.

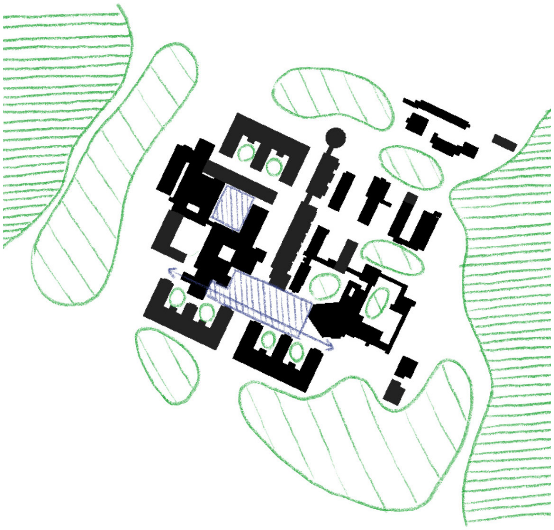


Fig. [4.17]: The open spaces around the campus are used as a communal recreational area for both ETH's academic community and the general public, offering picturesque views from Hönggerberg.

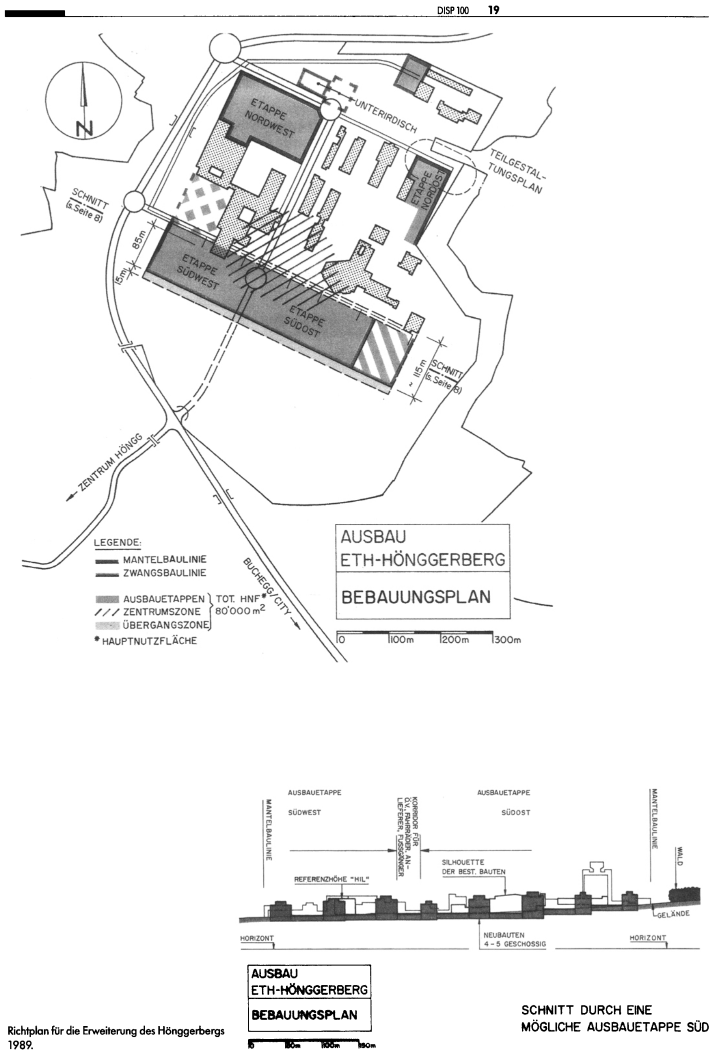


Fig. [4.18]: Richtplan 1989, While only one building was constructed as per this Richtplan, it significantly impacted the campus by introducing a new access route and architectural scale, which have influenced future projects at ETH and the university's evolving landscape and architectural identity.

Free/Green-Spaces

The trade-off for increased density within the campus is the reduction in the availability of contiguous open spaces. However, the southern portion now features a spacious square, thoughtfully conceived to interconnect essential functions and create a hub within the campus. This shift leaves less space between the buildings, although the interstitial areas have not been extensively landscaped. As a result, green spaces within the campus interior have become somewhat scarce, with the primary focus now being on preserving open spaces around the periphery of the campus.

Conclusion

Despite only one building being realized in accordance with this master plan, its influence on the current appearance of the campus cannot be understated. The introduction of a new access route from Höngg, which enhances north-south public transportation, and the establishment of a fresh architectural scale have set the tone for future construction projects at ETH, leaving an indelible mark on the university's evolving landscape and architectural identity. [4.7,4.8]

Science City
KCAP, 2005

ETH aimed to remain competitive on the international stage and prepared for the future. To achieve this, they are planning a modern, forward-looking campus called "Science City." The design competition for this project was won by the KCAP office, which has developed a concept with multiple variations.

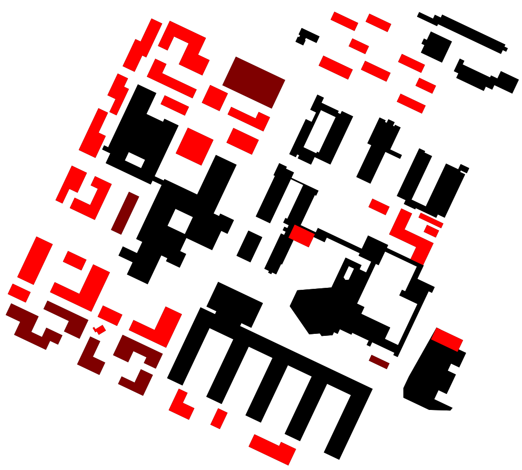


Fig. [4.19]: The shift from the cumbersome 1989 master plan to KCAP's innovative approach represents a pivotal moment in the ETH campus's development, as it embraces flexibility, adaptability, and global competitiveness in response to evolving academic needs and changing architectural trends.

Fig. [4.20]: Opposite Page

Analysis

History

The decision to include residential and working spaces within the campus is a testament to the holistic approach taken in designing the "Science City." This development aligns with contemporary trends in urban planning, where mixed-use areas foster a vibrant community, encourage collaboration, and create a lively atmosphere. The design competition, won by KCAP under the leadership of Kees Christiaanse, demonstrates a forward-thinking approach to university campus development. The recognition of the project in 2005 and the subsequent adaptation of special building regulations in 2007 underscore the commitment to seeing this vision through. This shift in planning philosophy not only enhances the educational and research environment at ETH but also transforms it into a dynamic, multifunctional hub where students, faculty, and researchers can live, work, and collaborate in a cohesive and modern setting, ensuring the institution's enduring relevance in the international academic arena. KCAP's vision, with its smaller and more adaptable buildings, acknowledges the importance of creating spaces that can keep pace with the rapidly changing landscape of education and research. By decentralizing the campus and spreading buildings along the periphery while maintaining central axes, the new plan not only offers functional advantages but also enhances the aesthetic and functional aspects of the campus. [4.9]

Composition

The transition from the unwieldy 1989 master plan to the innovative approach proposed by KCAP marks a significant turning point in the development of the ETH campus. The decision to move away from the large, rigid volumes of the previous plan and adopt a design that prioritizes flexibility and adaptability was not only a response to changing architectural trends but also a recognition of the evolving needs of the academic community and the desire to maintain global competitiveness.


0m 10m 50m 100m
masterplan szenario 1


0m 10m 50m 100m
masterplan szenario 2

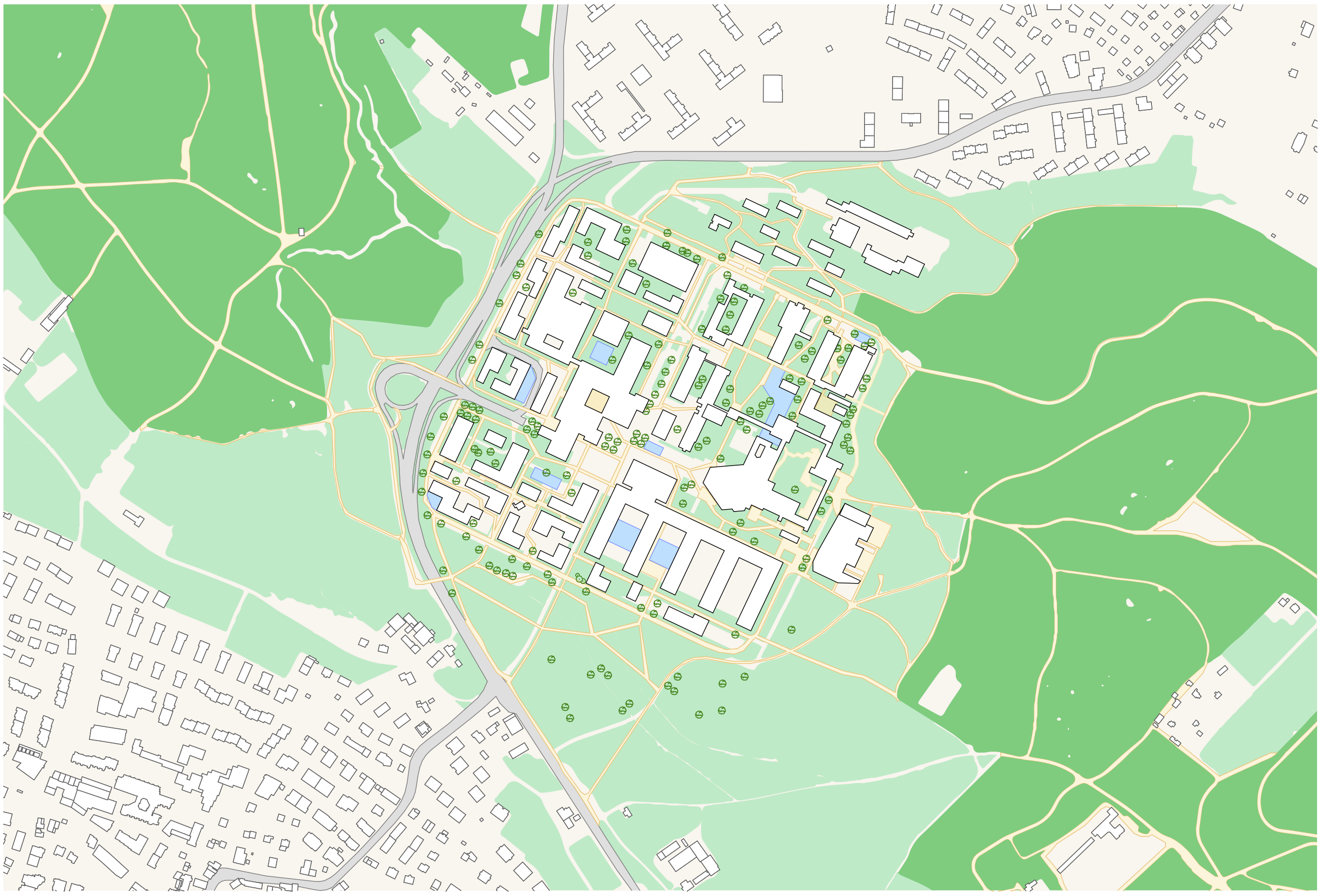


Fig. [4.21]:

Mobility

An essential aspect of the new master plan was the idea of becoming a part of the city, which had been hindered by poor connectivity. The new mobility plan proposed that bus lines would pass through ETH, leading to better integration into the city's transportation network in various directions. In KCAP's project, there was even a tramline planned to run across Hönggerberg, but this idea was never realized. The pedestrian network within the campus largely remains unchanged, except for the two main axes in the interior. However, a pathway surrounding the area in a square shape is being created, along with additional footpaths connecting to the surrounding areas.

Fig. [4.22]: In KCAP's project, there was even a tramline planned to run across Hönggerberg, but this idea was never realized.

Atmosphere

The atmosphere conveyed is highly diverse and dense. With the addition of various sizes and functions finding a place on campus, there is a very heterogeneous and urban impression. The connection to the city aims to make the campus a part of the city, but the outward appearance remains somewhat closed.

Fig. [4.23]: The new master plan aimed to integrate the campus into the city by improving transportation connectivity, including existing and new bus lines.

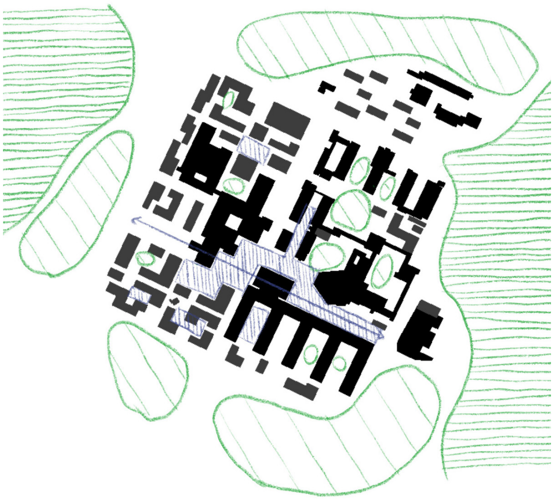


Fig. [4.24]: The green space in the campus remains primarily faithful to A.H. Steiner's layout, with minimal expansion, small green courtyards, a compromise due to planned residential units on the northern side

Free/Green-Spaces

The green space within the campus is hardly expanded, primarily focusing on A.H. Steiner's existing layout. There are a few small green courtyards, but the idea is still to maintain the outdoor space around the campus, even though this has been compromised to some extent on the northern side with the planning of residential units. The two main axes define the open space; the east-west axis is more for pedestrians, while the north-south connection is predominantly used by buses. Apart from the two main axes, the open space is similar, integrated where it connects buildings and is, accordingly, more fragmented.

Fig. [4.25]: HIT, The first building built with the "Science City" Masterplan

Fig. [4.26]: HWO Student Housing

Conclusion

KCAP's master plan brought the planning foundation to a forward-looking state and improved access to the city through public transportation. However, as new uses have not significantly materialized so far, there is little reason for the city's population to visit Hönggerberg. Unfortunately, the projects implemented through this master plan have only partially integrated into the existing framework and still do not seem entirely cohesive. Nevertheless, the pathway surrounding the area has clearly defined and enclosed the campus, making it challenging to envision buildings outside this boundary. [4.10]

Campus Hönggerberg 2040
EM2N, 2015

In order to accommodate the growth until 2040, significantly more space is needed in comparison to the new special building regulations of 2007. For this reason, EM2N, as the winners of a design competition, are entrusted with the task of further developing the "Science City" master plan.

Fig. [4.27]: The revised plan enhances existing elements by reworking and expanding the axes while adjusting granularity to harmonize with the existing buildings and introduces the concept of demolishing and replacing structures, representing a departure from past approaches.

Analysis

History

Following the development of "Science City," the Hönggerberg campus has experienced significant growth, necessitating predictions on how ETH will expand up to 2040. The calculated building volume amounts to approximately 1.9 million cubic meters, while the Special Building Ordinance of 2007 permits only 1.38 million. To address this, ETH initiated a pilot project involving various architectural firms, with EM2N being selected to continue it in a new master plan. Key features of this new plan include adapting the existing master plan and intensifying the campus's density. Consequently, high-rise buildings are being considered on Hönggerberg for the first time since A.H. Steiner's proposals, despite opposition from neighborhood associations and residents. This remains a crucial point of discussion to balance development with the preservation of open spaces. [4.11]

Composition

In the revised plan, existing elements undergo a thorough reworking, with specific attention given to expanding and clarifying the axes. The granularity, which may have been somewhat undersized in the 2005 plan, is now adjusted to harmonize with the existing building stock, resulting in a more uniform overall plan. Notably, this master plan introduces the concept of demolishing and replacing buildings, marking a departure from previous approaches.

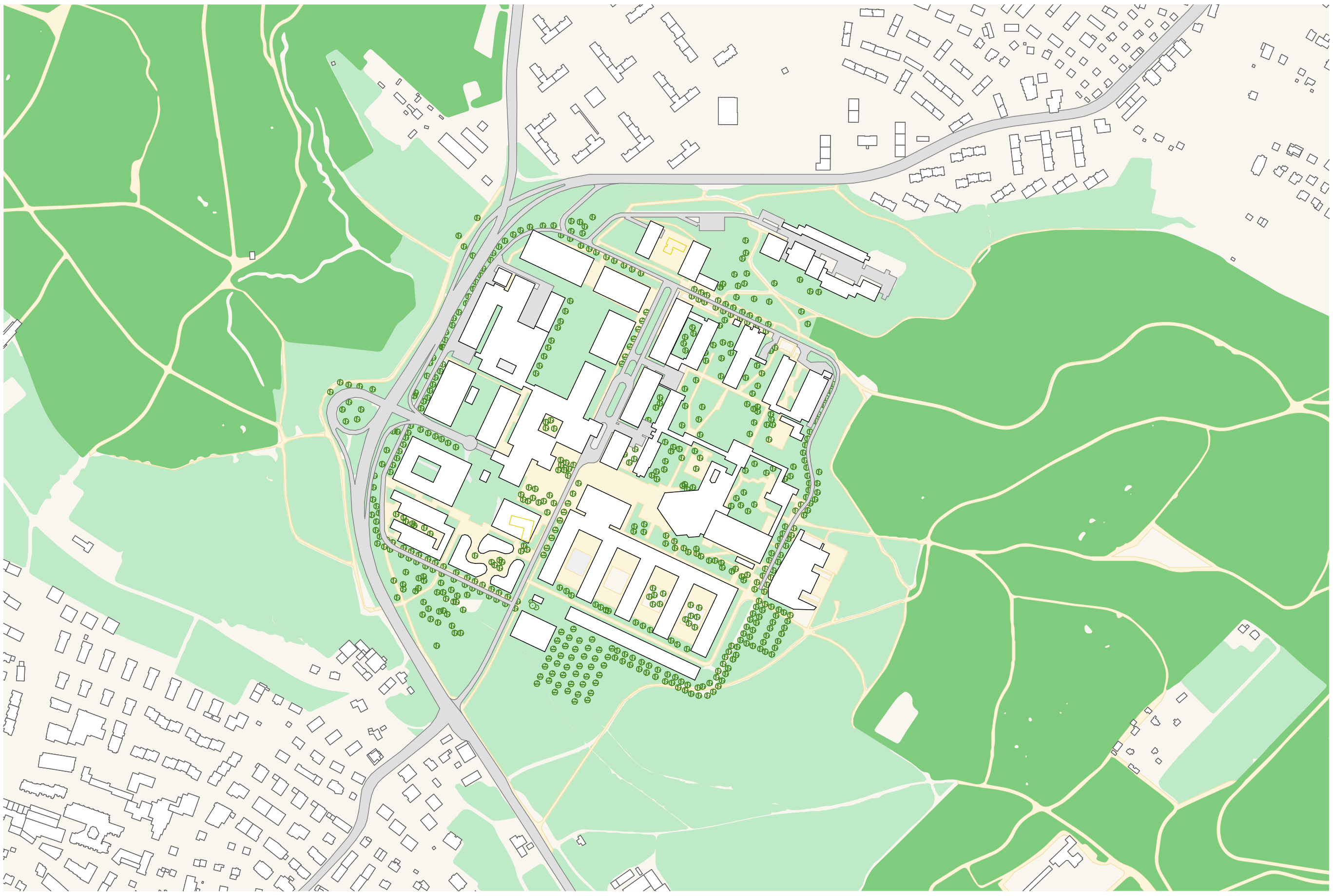


Fig. [4.29]: The new master plan envisions an urban landscape that could integrate into the city but raises questions about its adaptability in a rapidly changing era.

Mobility

At this time, only 7% of individuals travel to Hönggerberg by motorized individual transport (MIT), which are still parked in the underground facilities. The vast majority, approximately 84%, rely on public transportation (Öffentlicher Verkehr or ÖV in German). Consequently, there's an expansion of public transportation services, with adjustments made to the bus schedule and increased frequencies. However, the idea of a tram line is not further pursued. The pedestrian network remains relatively unchanged, with a new competition focusing on the Wolfgang-Pauli Strasse to enhance the pedestrian experience.

Atmosphere

The new master plan paints an urban picture that could seamlessly integrate into the city's fabric. On one hand, it seems designed to accommodate contemporary needs, but at the same time, it appears somewhat rigid, raising questions about its adaptability in a rapidly changing era.

Fig. [4.30]: Currently, most people (84%) use public transportation to reach Hönggerberg, leading to an expansion of services and increased bus frequencies, while the idea of a tram line is dropped, and there's a competition to improve the pedestrian experience on Wolfgang-Pauli Strasse.

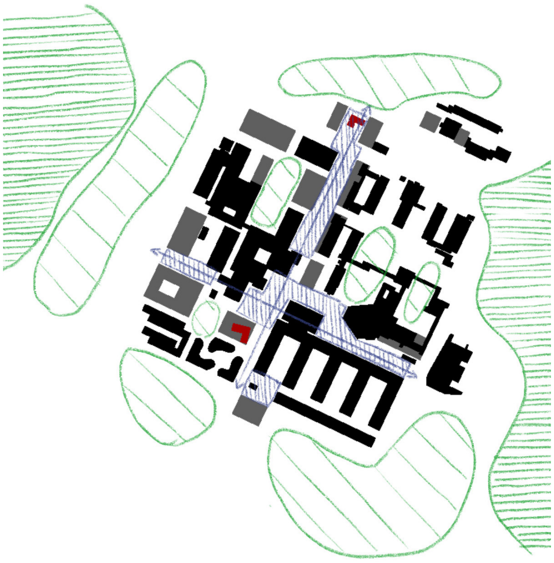


Fig. [4.31]: With a significant portion of the area developed, there's a focus on optimizing existing open spaces while continuing the concept of central axes and maintaining undeveloped surrounding landscape

Free/Open Spaces

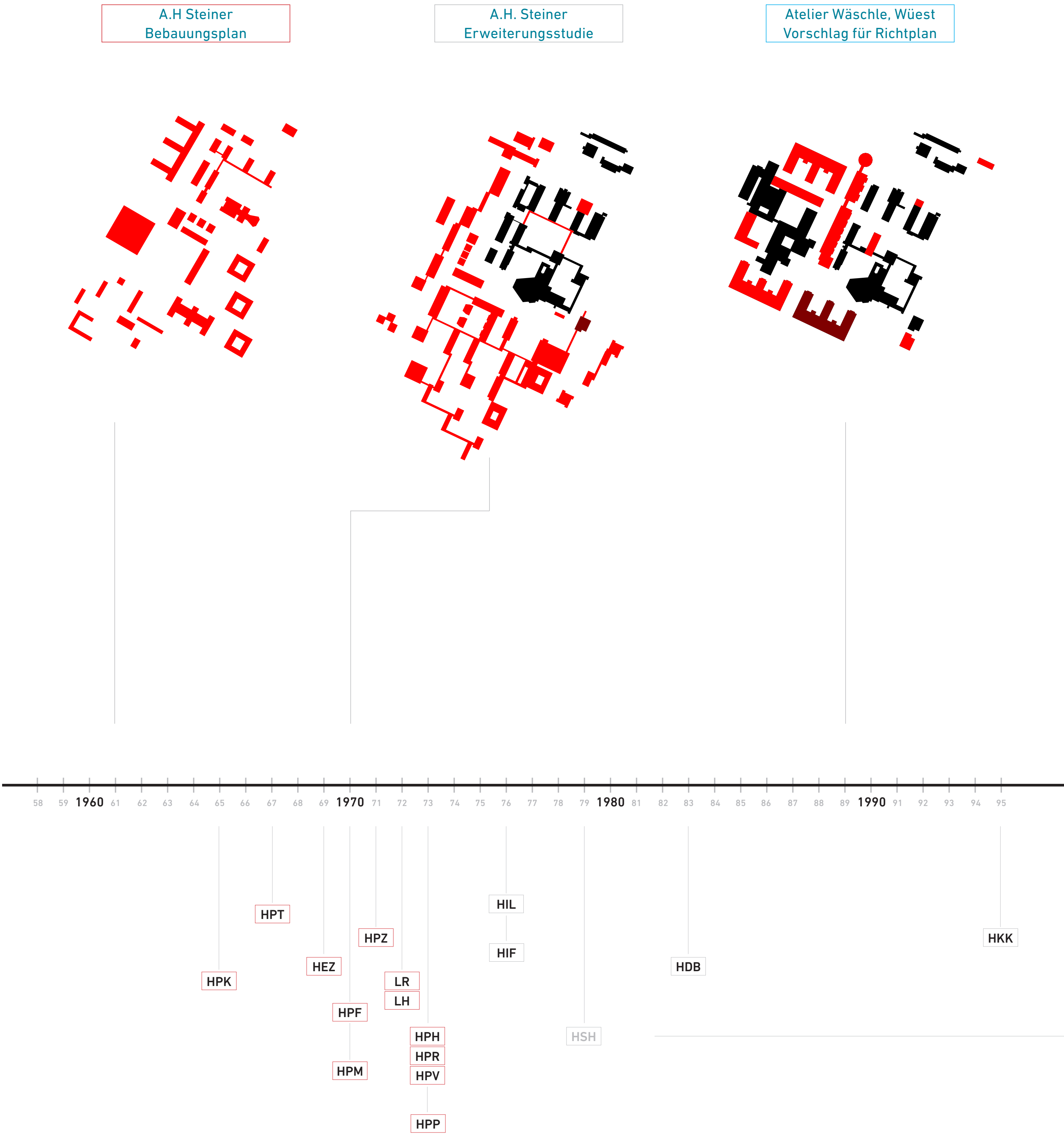
Given that a significant portion of the area is now developed, it's crucial to consider how to utilize the existing open spaces. The concept of two central axes is continued and enclosed with northern and southern entrances. As the emphasis remains on increasing density within the campus, it's vital that the surrounding landscape remains undeveloped, especially as a substantial portion of the interior space is now sealed off, except for a few areas. The green space is clearly defined and demarcated in the new plan, giving it a somewhat artificial appearance.

Fig. [4.32]: Evaluating the success of "Masterplan Hönggerberg 2040" is difficult due to the recent revision of the Special Building Ordinance.

Conclusion

Assessing the success of the "Masterplan Hönggerberg 2040" is challenging, as the Special Building Ordinance was only revised in 2017, and only one new building has been constructed since then. However, it's worth considering whether a master plan primarily focused on large-scale new constructions is the right approach in an era where we question the extent to which we should continue building anew. [4.14]

Fig. [4.33]: Contribution to the Competition for the new Design of the Wolfgang-Pauli street.


A.H Steiner
Bebauungsplan
A.H. Steiner
Erweiterungsstudie
Atelier Wäschle, Wüest
Vorschlag für Richtplan
58 59 1960 61 62 63 64 65 66 67 68 69 1970 71 72 73 74 75 76 77 78 79 1980 81 82 83 84 85 86 87 88 89 1990 91 92 93 94 95
HPK
HPT
HEZ
HPF
HPM
HPZ
LR
LH
HPH
HPR
HPV
HPP
HIL
HIF
HSH
HDB
HKK


KCAP
Masterplan "Science City"
EM2N
Masterplan "Campus Hönggerberg 2040"
???
96 97 98 99 2000 01 02 03 04 05 06 07 08 09 2010 11 12 13 14 15 16 17 18 19 2020 21 22 23 24 25 26 27 28 29 2030 31 32
HPI
HCI
HPW
HIT
HPS
HPL
HIA
HCP
HIB
HPG
HIN
HPQ
HPQ
HPQ

[4.2, 4.12, 4.15]

Sources

List of References 122

List of Figures 129

List of References

Reaching 2050

[1.1]: BP Statistical Review of World Energy, 2020 (via Energieschweiz, 2021: Energieverbrauch weltweit und in der Schweiz, Bern).

[1.2]: BFE, 2022: Schweizerische Gesamtenergiestatistik 2022, Bern.

[1.3]: BFE, 2019: Energieperspektive 2050+, Bern.

[1.4]: Gis-Broswer, 2023: maps.zh.ch, Zürich.

[1.5]: Stadt Zürich, 2019: Planungsbericht Energieversorgung, Zürich.

[1.6]: ETH Immobilien, 2019: Excel Energieausweisklassen, Zürich.

ETH Immobilien, 2019: Excel Energieauswertung, Zürich.

[1.7]: Brem, Dominik, Head of Engineering and Systems ETH, 31.11.2023: personal Interview about ETH Systems, Zürich.

[1.8]: Wäber, Alexander, ETH Immobilien, 19.09.2023: Präsentation Studio Introduction, Zürich.

[1.9]: Lienhart, Johannes, ETH D-MAVT Spin Off Robotics, 15.11.2023: Personal Talk, Zürich.

[1.10]: Eyer, Klaus, Prof, ETH D-CHAB, 17.11.2023: Personal Talk, Zürich.

[1.11]: ETH Immobilien, 2022: Richtlinien Laborbauten, Zürich.

[1.12]: Pfister, Cédric, Keller, Lisa, Students MsC in Lab at GLC, 15.11.2023: Personal Talk, Zürich.

[1.13]: Schweizer Bauzeitung, Schindler-Fässler G., Schindler C, 1944: Das Wärmepumpen-Ergänzungswerk Walcheplatz, Zürich, des Fernheizkraftwerkes der E.T.H. , Zürich.

[1.14]: Bulletin des Schweizerischen Elektrotechnischen Vereins, Piazzoli N., Tresch R., 1988: Neue Wärmepumpenanlage für die Eidgenössische Technische Hochschule in Zürich, Zürich.

[1.15]: Kanton Zürich, 2019: Massnahmenplan Abfall- und Ressourcenwirtschaft 2019-2022, Zürich.

[1.16]: Stadt Zürich, 2017: Überprüfung der Kapazitäts- und Standortplanung der thermischen Verwertung von Abfällen im Kanton Zürich 2012-2035, Zürich.

[1.17]: ERZ, 2008: Umweltpraxis, Zürich.

[1.18]: Stadt Zürich, 2015: Hochschulgebiet Zürich-Zentrum Schlussbericht Vertiefungsthema Energieversorgung, Zürich.

Kanton Zürich, 2014: Masterplan Hochschulgebiet Zürich-Zentrum, Zürich.

[1.19]: EWZ, 2019: Seewasser als klimafreundliche Energiequelle, Zürich.

[1.20]: ETH Immobilien, 2022: Excel Jahresauswertung 2022, Zürich.

[1.21]: E360, Seewassernutzungen, 2023: https://www.energie360.ch/de/magazin/energiezukunft/seewasser-nutzung/.

[1.22]: EWZ, 2023: Klimafreundliche Verbundlösungen für Städte und Gemeinden, Zürich.

[1.23]: Eawag, 2020: Seewassernutzung Unteres Seebecken, Zürich.

ZUP Energie (Stadt Zürich), Schmid, Benjamin, 2023: Energieverbund Lengg: Seewasser wärmt und kühlt, Zürich.

[1.24]: ETH Board, 2022: Annual Report 2022, Zürich.

ETH Zürich, 2022 (data from 2020): ETH Zurich strives for Net Zero by 2030.

ETH SSC, 2023: Energy security in a net zero emissions future for switzerland, Zürich.

[1.25]: ETH Immobilien, 2019: Die Energie von Morgen, Zürich.

[1.26]: Energia, 2021: https://energeiaplus.com/2021/04/19/wie-die-eth-zuerich-sich-selbst-mit-energie-versorgt/ , Bern.

Espazium, Sulzer, Matthias, 2015: https://www.espazium.ch/de/aktuelles/untergrundspeicher-ohne-defizit-garantie.

Energieschweiz, 2018: Fallbeispiel "thermische Netze", Bern.

[1.27]: Stadt Zürich, 2022: https://www.stadt-zuerich.ch/gud/de/index/umwelt_energie/2000-watt-gesellschaft.html.

[1.28]: FHNW, Axel Schubert: Kommentar zu 2000 Watt Gesellschaft der Stadt Basel, Basel.

[1.29]: Energieschweiz, 2021: Factsheet 2000 Watt Gesellschaft, Bern.

[1.30]: Energieschweiz, 2020: Leitkonzept 2000 Watt Gesellschaft, Bern.

[1.31]: Blindenbacher, Thomas, Amstein Walthert AG, 10.10.2023: personal phone call about 2000 Watt Society, Zürich.

[1.32]: Republik, Antje Stahl, Saskia Rosset, ZAS*, 2022: Stoppt die Vorschlaghämmer!, Zürich.

[1.33]: Kuny, Tamino, ZAS*, 2023: personal talk about 2000 Watt society and labels, Zürich.

[1.34]: ETH Immobilien, 2020: Immobilienstrategie, Zürich.

ETH Immobilien, 2021: RFGK 2021-2024, Zürich.

[1.35]: Enz, Matyas, Architecture Student, 03.11.2023: personal talk about labels, Zürich.

[1.36]: Minergie, 2023: https://www.minergie.ch/de/standards/neubau/.

[1.37]: BFE, 2016: Erfolgskontrolle Gebäudeenergiestandards 2014-2015, Bern.

BFE, 2018: WP-GAP: Performance Gap, Bern.

BFE, 2016: Evaluation Gebäudestandards: https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen.msg-id-61121.html Adligenswil / Zürich.

Lemon Consult, 2016: Performance Gap, Zürich.

[1.38]: Enz, Matyas, 2023: Fokus Arbeit ETHZ Chair Tom Emerson: Ueli Schäfer Solarpionier, Zürich.

[1.39]: International Alliance of Research Universities, 2017: Behaviour Change Interventions for reduced energy use, best practice for universities, cambridge.

[1.40]: Copenhagen University, 2022: Knowledge and Responsiblity, Copenhagen.

[1.41]: Energieschweiz, 2017: Graue Energie von Neubauten, Ratgeber für Fachleute, Bern.

Future Strategies for ETH's Building Stock

[2.1]: ETH Zürich, Abteilung Immobilien. *RFGK 2021 - 2024.* ETH Zürich, Zürich, 2020, p. 7.

[2.2]: ETH Zürich, Abteilung Immobilien. *RFGK 2021 - 2024.* ETH Zürich, Zürich, 2020, p. 3.

[2.3]: ETH Zürich, Abteilung Immobilien. *Richtlinie Nachhaltigkeit.* ETH Zürich, Zürich, 2021, p. 3.

[2.4]: *Bundesgesetz über die Verminderung von Treibhausgasemissionen (CO2-Gesetz)* of the Swiss Federal State, 2020.

[2.5]: ETH Zürich, Abteilung Immobilien. *Richtlinie Nachhaltigkeit.* ETH Zürich, Zürich, 2021, pp. 6-10.

[2.6]: Steger, Sören, et al. *Energetische Sanierung von Bestandsgebäuden oder Neubau.* Wuppertal Institut für Klima, Umwelt, Energie gGmbH, Wuppertal, 2022.

[2.7]: Alig, M., Frischknecht, R., Krebs, L., Ramseier, L., Stolz, P. (2021). *LCA of climate friendly construction materials.* Treeze Ltd. , Uster, 2020, pp. 83.

[2.8]: Bundesamt für Energie BFE. *Energieperspektiven 2050+: Zusammenfassung der wichtigsten Ergebnisse.* Bundesamt für Energie BFE, Ittigen, 2020.

[2.9]: D'Amico, Bernardino & Francesco Pomponi. *A Compactness Measure of Sustainable Building Forms.* Edinburgh Napier University, Edinburgh, 2019, p. 1.

[2.10]: Edler, Christopher. *Dicht oder kompakt?: ein Vergleich der baulichen Dichte mit der Gebäudeform: Determinanten des Energieaufwandes im Lebenszyklus von Wohngebäuden.* Eidgenössische Technische Hochschule Zürich, Zürich, 2005, pp. 36-41.

[2.11]: Anders, Stephan. *Mehrwert nachhaltiger Stadtquartiere* in: Anders, Stephan, et al. *Nachhaltige Stadtquartiere.* Detail Verlag, München, 2013, pp. 28-31.

[2.12]: Bott, Helmut & Stefan Siedentop. *Regional-, Stadt- und Quartiersentwicklung* in: Anders, Stephan, et al. *Nachhaltige Stadtquartiere.* Detail Verlag, München, 2013, pp. 36-38.

[2.13]: Bott, Helmut & Stefan Siedentop. *Regional-, Stadt- und Quartiersentwicklung* in: Anders, Stephan, et al. *Nachhaltige Stadtquartiere.* Detail Verlag, München, 2013, pp. 36-38.

[2.14]: Hüchtker, Sibille et al. *Freiräume, Siedlung, Kooperationen: Forschungsergebnisse, Hinweise für die Praxis, Folgerungen.* Dortmunder Vertrieb für Bau- und Planungsliteratur, Dortmund, 2000, p. 54.

[2.15]: Stokman, Antje. *Wasser- und Bodenschutz* in: Anders, Stephan, et al. *Nachhaltige Stadtquartiere.* Detail Verlag, München, 2013, pp. 96-105.

[2.16]: Randolph, John. *Environmental Land Use Planning and Management: Creating Sustainable Communities, Watersheds, and Ecosystems.* 2nd Edition, Island Press, Washington, D.C., 2012, pp. 173-183.

[2.17]: Barton, Hugh. *City of Well-being: A radical guide to planning.* Routledge, New York, 2017, pp. 95-98.

[2.18]: Barton, Hugh. *City of Well-being: A radical guide to planning.* Routledge, New York, 2017, pp. 136-139.

[2.19]: Pustal, Waltraud, et al. *Freiräume und Stadtklima* in: Anders, Stephan, et al. *Nachhaltige Stadtquartiere.* Detail Verlag, München, 2013, pp. 88-92.

Future for Rooms | Rooms for Future

[3.1]: Wäber, Alexander, et al. *Räumliches und finanzielles Gesamtkonzept 2021-2024*, 2020, p. 17.

[3.2]: Lingk, Andrea, et al. *ETH Zürich Annual Report 2022*, 2022, p. 16.

[3.3]: Planpartner AG. *Sonderbauvorschriften ETH Zürich Campus Hönggerberg*, 2018, p. 8.

[3.4]: Mocek, Susanne. *Wo Zukunft entsteht, Neubau HIC, Campus Hönggerberg, Bericht des Preisgerichts*. Real Estate Management Departement ETH, 2020, p. 7.

[3.5]: ETH Zürich, Real Estate Management Department. *Handbuch für Innovative Unterrichtsräume an der ETH*, 2023, p. 3.

[3.6]: ETH Zürich, Real Estate Management Department. *ETH Real Estate Strategy*, Foreword, 2020, p. 5.

[3.7]: ETH Zürich, Real Estate Management Department. *Handbuch für Innovative Unterrichtsräume an der ETH*, 2023, pp. 12-23.

[3.8]: ETH Zürich, Real Estate Management Department. *Handbuch für Innovative Unterrichtsräume an der ETH*, 2023, pp. 24-32.

[3.9]: Bucheli, Daniel. *Bauliche Entwicklung der ETH Zürich, Standortspezifische Vertiefung Campus Hönggerberg*. Real Estate Management Departement ETH, 2020, p. 23.

[3.10]: Pimentel, Daniel. *An Introduction into learning in the Metaverse*. Meridian Treehouse, 2022, p. 2, pp. 5-7.

[3.11]: Marr, Bernard. *What Is Extended Reality Technology? A Simple Explanation For Anyone*. Forbes, 2019. https://www.forbes.com/sites/bernardmarr/2019/08/12/what-is-extended-reality-technology-a-simple-explanation-for-anyone/.

[3.12]: Imannezhad, Shima, et al. *Metaverse in Education; an Overview of Systematic Reviews*. Med Edu Bull, 2023, pp. 736-739.

[3.13]: Gramazio, Fabio. *Immersive Studio, Architectural Design*. ETH Zürich, 2023. https://ww2.lehrbetrieb.ethz.ch/id-workflows/faces/instances/Innovedum/ProzessInnovedum$1/18BD9C72263F669B/innovedumPublic.Details/Details.xhtml.

[3.14]: Pimentel, Daniel. *An Introduction into learning in the Metaverse*. Meridian Treehouse, 2022, p. 2, p. 10.

[3.15]: Lehner, Hermann. *ETH Eduspaces, occupancy density of lecture halls and seminar rooms*, 2021, pp. 8-11.

[3.16]: ETH Zürich, Raum- und Stundenplanung. *Mietpreise Rektoratsräume*, 2023.

[3.17]: De Vylder, Jan. *Ours Yours Office*, HIL F 56, ETH Zürich. https://de-vylder.arch.ethz.ch/carrousel-hil-f-56/.

[3.18]: Gaming and Entertainment Committee of the VSETH. *PolyLAN Zürich*, 2023. https://geco.ethz.ch.

[3.19]: Zettl, Mark. *Office Buildings Are Still Less Than 50% Occupied. Who Should Worry?*, Forbes, 2022. https://www.forbes.com/sites/markzettl/2022/11/29/office-buildings-are-still-less-than-50-occupied-who-should-worry/.

[3.20]: Wakabayashi, Daisuke. *Google's Plan for the Future of Work: Privacy Robots and Balloon Walls*, The New York Times, 2021, [quote]. https://www.nytimes.com/2021/04/30/technology/google-back-to-office-workers.html.

[3.21]: Mateescu, Magdalena, et al. *Evaluation of the Future of Work Survey*, FNHW & ETH Zürich, 2023. https://ethz.ch/content/dam/ethz/associates/services/Anstellung-Arbeiten/Rund_um_die_Anstellung/anstellung-und-arbeit/flexibles-arbeiten/future-of-work/FoW_Umfrage_2022_Auswertung_EN.pdf, pp. 16-23.

[3.22]: Mateescu, Magdalena, et al. *Evaluation of the Future of Work Survey*, FNHW & ETH Zürich, 2023, [quote]. https://ethz.ch/content/dam/ethz/associates/services/Anstellung-Arbeiten/Rund_um_die_Anstellung/anstellung-und-arbeit/flexibles-arbeiten/future-of-work/FoW_Umfrage_2022_Auswertung_EN.pdf, p. 21.

[3.23]: Mateescu, Magdalena, et al. *Evaluation of the Future of Work Survey*, FNHW & ETH Zürich, 2023. https://ethz.ch/content/dam/ethz/associates/services/Anstellung-Arbeiten/Rund_um_die_Anstellung/anstellung-und-arbeit/flexibles-arbeiten/future-of-work/FoW_Umfrage_2022_Auswertung_EN.pdf, pp. 33-39.

[3.24]: Adi, Gaskell. *How Eco-Friendly Is Remote Working?*, Forbes, 2021. https://www.forbes.com/sites/adigaskell/2021/10/21/how-eco-friendly-is-remote-working/.

[3.25]: Mateescu, Magdalena, et al. *Evaluation of the Future of Work Survey*, FNHW & ETH Zürich, 2023. https://ethz.ch/content/dam/ethz/associates/services/Anstellung-Arbeiten/Rund_um_die_Anstellung/anstellung-und-arbeit/flexibles-arbeiten/future-of-work/FoW_Umfrage_2022_Auswertung_EN.pdf, pp. 40-43.

[3.26]: Weihs, Constanze. *Workplace consulting for ETH*, ETH Zürich, 2023, [quote]. https://ethz.ch/staffnet/en/news-and-events/internal-news/archive/2023/08/workplace-consulting-for-eth.html.

[3.27]: Gasser, Bianca. *Workspaces of the Future appear in Oerlikon*, VPPL, ETH Zürich, 2020. https://ethz.ch/staffnet/en/news-and-events/internal-news/archive/2020/12/in-oerlikon-entstehen-arbeitsraeume-der-zukunft.html.

[3.28]: ETH Zürich, Real Estate Management Department, *Future of Work @ OCT Info-Veranstaltung: Stockwerksbelegung / Module*, 2023. https://ethz.ch/content/dam/ethz/associates/services/organisation/departments/immobilien/workplace-consulting/Future_of_Work/20230926_FoW@OCT_Info-Veranstaltung_September.pdf, p. 10.

[3.29]: ETH Zürich, Real Estate Management Department, *Future of Work @ OCT Info-Veranstaltung: Stockwerksbelegung / Module*, 2023. https://ethz.ch/content/dam/ethz/associates/services/organisation/departments/immobilien/workplace-consulting/Future_of_Work/20230926_FoW@OCT_Info-Veranstaltung_September.pdf, p. 15.

[3.30]: Wakabayashi, Daisuke. *Google's Plan for the Future of Work: Privacy Robots and Balloon Walls*, The New York Times, 2021. https://www.nytimes.com/2021/04/30/technology/google-back-to-office-workers.html.

[3.31]: ETH Zürich, Real Estate Management Department. *Bundesamt für Bauten und Logistik, Standards für Büro- und Verwaltungsgebäude im Inland*, 2020, p. 12.

[3.32]: Gasser, Bianca. *Workspaces of the Future appear in Oerlikon*, VPPL, ETH Zürich, 2020, [quote]. https://ethz.ch/staffnet/en/news-and-events/internal-news/archive/2020/12/in-oerlikon-entstehen-arbeitsraeume-der-zukunft.html.

[3.33]: Gasser, Bianca. *Workspaces of the Future appear in Oerlikon*, VPPL, ETH Zürich, 2020. https://ethz.ch/staffnet/en/news-and-events/internal-news/archive/2020/12/in-oerlikon-entstehen-arbeitsraeume-der-zukunft.html.

[3.34]: Wikipedia, *The Great Good Place (book*), 2023. https://en.wikipedia.org/wiki/The_Great_Good_Place_(book).

[3.35]: Florian, Maria-Cristina. *All Purpose Homes: Are Residential Spaces Taking Over the Role of First, Second, and 'Third Places'?*, ArchDaily, 2023. https://www.archdaily.com/999419/all-purpose-homes-are-residential-spaces-taking-over-the-role-of-first-second-and-third-places.

[3.36]: Equipe ArchDaily Brasil. *Atelier Marko Brajovic Creates Home Office Capsule That Fits in Any House*, ArchDaily, 2020. https://www.archdaily.com/946633/atelier-marko-brajovic-creates-home-office-capsule-that-fits-in-any-house?ad_campaign=normal-tag.

[3.37]: Mateescu, Magdalena, et al. *Evaluation of the Future of Work Survey*, FNHW & ETH Zürich, 2023. https://ethz.ch/content/dam/ethz/associates/services/Anstellung-Arbeiten/Rund_um_die_Anstellung/anstellung-und-arbeit/flexibles-arbeiten/future-of-work/FoW_Umfrage_2022_Auswertung_EN.pdf, p. 4.

[3.38]: Kovar, Joseph F. *Google Cracks Down On Work From Home, Tells Workers To Return To The Office*, CRN, 2023. https://www.crn.com/news/cloud/google-cracks-down-on-work-from-home-tells-workers-to-return-to-the-office.

[3.39]: Mozas, Javier, et al. *The Office on the Grass, The Evolution of the Workplace*. a+t architecture publishers, Vitoria-Gasteiz, 2017, p.58.

[3.40]: Adi, Gaskell. *How Remote Work Has Affected Real Estate Values*, Forbes, 2023. https://www.forbes.com/sites/adigaskell/2023/03/05/how-remote-work-has-affected-real-estate-values/.

[3.41]: Brand David. *The country's biggest office-to-apartment conversion is underway inside the old Daily News office*, Gothamist, 2023. https://gothamist.com/news/the-countrys-biggest-office-to-apartment-conversion-is-underway-inside-the-old-daily-news-office.

[3.42]: The Economist, *How are offices changing?*, 2022, [Video]. https://www.youtube.com/watch?v=BtSWnWmbHZk.

[3.43]: Partridge, Joanna. *Switch to more home working after Covid 'will make gender inequality worse'*, The Guardian, 2021. https://www.theguardian.com/business/2021/jun/19/switch-to-more-home-working-after-covid-will-make-gender-inequality-worse.

[3.44]: Federal Statistical Office, *Place of work, teleworking*, 2022. https://www.bfs.admin.ch/bfs/en/home/statistics/work-income/employment-working-hours/working-conditions/place-work.html.

[3.45]: Gattupalli, Ankitha. *UniverCities: The Integration of the Campus and its City*, ArchDaily, 2023. https://www.archdaily.com/996393/univercities-the-integration-of-the-campus-and-its-city.

[3.46]: Gruppe ‹Unmasking Space›. *Unmasking Space*, Hochparterre, 2023. https://www.hochparterre.ch/campus/unmasking-space.

[3.47]: CARTHA Magazine. *The City as a University - Panta Rhei Collaborative*, 2022, [Video]. https://vimeo.com/742381474?embedded=true&source=vimeo_logo&owner=42754380.

[3.48]: ETH Zürich, Real Estate Management Department, *04_SBV_ETH_Auflage_Planungsbericht.pdf*, 2020, p. 48.

Past and current Visions for Campus Hönggerberg

[4.1]: A. H. Steiner: *Die Entstehung der Hochschulbauten ETH Honggerberg Zurich*, Dokumentation, 1983.

[4.2]: *Die Planung der ETH Hönggerberg 1957–1990*, disP - The Planning Review, 26:100, 5-20 (1990).

[4.3]: Hanhart, Hans U. / Risch, Gaudenz, *Schweizerische Bauzeitung*, Band 86, Heft 21, S.353-383 (1968).

[4.4]: B.O., *Schweizerische Bauzeitung*, Band 94, Heft 42, S.623-633 (1976).

[4.5]: Competitions, *Schweizerische Bauzeitung*, Band 107, Heft 16, S.425-432 (1989).

[4.6]: Competitions, *Schweizerische Bauzeitung*, Band 109, Heft 23, S.556-559 (1989).

[4.7]: Fritz Widmer, *Schweizerische Bauzeitung*, Band 116, Heft 24, S.448-451 (1998).

[4.8]: Schulleitung der ETH Zürich, *ETH Bulletin Nr. 282*, S.7-13 (2001).

[4.9]: Präsentation, KCAPArchitects&Planners, *Gestaltungskonzept Masterplan Science City*, Version 3.0, (2007).

[4.10]: Kord Büning-Pfaue, *Werk,Bauen+Wohnen*, Band 95, Heft 12, S.48-52 (2008).

[4.11]: ETH Zürich, Infrastrukturbereich Immobilien, *Erläuterungsbericht Masterplan 2040* (2016).

[4.12]: Andreas Kohne, *Dichter und höher ETH Campus Hönggerberg, Masterplan 2040*, (2018).

[4.13]: Gemeinderat Stadt Zürich, *Sonderbauvorschriften «ETH Zürich, Campus Hönggerberg»* (2020).

[4.14]: ETH Zürich, Abteilung Engineering & Systeme, *Nachhaltigkeitsstrategie Campus Hönggerberg* (2021).

[4.15]: Präsentation, ETH Zürich Abteilung Immobilien, Sektion Portfoliomanagemen (2023).

List of Figures

Front Page

Fig. [0.1]: Scazigino, Hans. *Zürich, ETH Zürich, Eidgenössische Sternwarte, östliches Meridianzimmer.* ETH-Bibliothek Zürich, Bildarchiv, 1911. Copyright by Johann Rudolf Wolf.

Reaching 2050

Fig [1.0]: Own representation based on: HPL, René Dürr.

Fig [1.1]: Own representation based on: BFE.

Fig [1.2]: Own representation based on: ETH Immobilien, Masterplan Hochschulgebiet, EWZ Seewassernutzung.

Fig [1.3]: Own representation based on: Masterplan Hochschulgebiet, EWZ Seewassernutzung.

Fig [1.4]: Own representation based on: Excel Energieauswertung, Annual Report.

Fig [1.5]: Own representation based on: Pläne EWZ.

Fig [1.6]: Own representation based on: Bericht Energie der Zukunft.

Fig [1.7]: Ilg Santer Architekten.

Fig [1.8]: Own representation based on: Dominik Brem.

Fig [1.9]: Albert Steiner.

Fig [1.10]: Own representation based on: Schweizer Bauzeitung, Bulletin.

Fig [1.11]: E-periodica.

Fig [1.12]: Own representation based on: Annual Report.

Fig [1.13]: Own representation.

Fig [1.14]: Own representation based on: Dominik Brem.

Fig [1.15]: Own representation based on: Excel Energieauswertung, Annual Report.

Fig [1.16]: Own representation based on: Annual Report, Eawag.

Fig [1.17]: Own representation based on: this Report.

Fig [1.18]: Own representation based on: Annual Report, BFE.

Fig [1.19]: Living Lab of the Chair of Architecture and Building Systems.

Fig [1.20]: Minergie houses.

Fig [1.21]: Own representation.

Future Strategies for ETH's Building Stock

Fig. [2.1]: Own representation.

Fig. [2.2]: Fischer Architekten AG. HPM2 ETH *Hönggerberg*, Zürich. Accessed November 17, 2023. https://www.fischer-architekten.ch/de/projekte/hpm2-eth-hoenggerberg-zuerich.

Fig. [2.3]: Own representation.

Fig. [2.4]: ETH Zürich, Abteilung Immobilien. *HIF – für die Bauten, Infrastrukturen und natürlichen Ressourcen der Zukunft.* Accessed November 17, 2023. https://ethz.ch/de/campus/entwickeln/bauprojekte/hif-projekt.html.

Fig. [2.5]: Own representation.

Fig. [2.6]: Own representation.

Fig. [2.7]: Own representation.

Fig. [2.8]: Fig. [2.8]: Bundesamt für Energie BFE. *Energieperspektiven 2050+: Zusammenfassung der wichtigsten Ergebnisse.* Bundesamt für Energie BFE, Ittigen, 2020, p. 21.

Fig. [2.9]: Own representation.

Fig. [2.10]: Own representation based on: Anders, Stephan, et al. *Nachhaltige Stadtquartiere*. Detail Verlag, München, 2013, p. 31.

Fig. [2.11]: Stadtgärtnerei Basel Stadt. *Erlenmattpark.* Accessed November 17, 2023. https://www.stadtgaertnerei.bs.ch/stadtgruen/park-gruenanlagen/erlenmattpark.html.

Fig. [2.12]: Own representation based on: *Bundes-Bodenschutzgesetz (BBodSchG)* of the Federal Republic of Germany.

Fig. [2.13]: Gerber, Wolfgang. *Vom Gestein zum Boden.* Accessed November 17, 2023. https://www.friedrich-verlag.de/friedrich-plus/sekundarstufe/geographie/bodenkunde/vom-gestein-zum-boden-2138.

Fig. [2.14]: Own representation.

Future for Rooms | Rooms for Future

Fig. [3.1]: Own representation based on: Wäber, Alexander, et al. *Räumliches und finanzielles Gesamtkonzept 2021-2024*, 2020, p. 17. Planpartner AG. Sonderbauvorschriften ETH Zürich Campus Hönggerberg, 2018, p. 8.

Fig. [3.2]: ETH Zürich, Real Estate Management Department. *ETH Real Estate Strategy*, 2020, p. 26.

Fig. [3.3]: ETH Zürich, Homepage. *Pictures Rectorate Rooms* [digital photographs]. https://ethz.ch/staffnet/en/service/rooms-and-buildings/rectorate-rooms/pictures.html.

Fig. [3.4]: ETH Zürich, Homepage. *Pictures Rectorate Rooms, HG - Main Building* [digital photograph]. https://ethz.ch/staffnet/en/service/rooms-and-buildings/rectorate-rooms/pictures/hg.html.

Fig. [3.5]: ETH Zürich, Real Estate Management Department. *Handbuch für Innovative Unterrichtsräume an der ETH*, 2023, p.22.

Fig. [3.6]: Lex Fridman. *First Interview in the Metaverse* [Video]. 2023. Youtube. https://www.youtube.com/watch?v=MVYrJJNdrEg.

Fig. [3.7]: Licens, Scott, et al. *PwC VR Soft Skills training Efficacy Study*, 2020. https://www.pwc.com/us/en/tech-effect/emerging-tech/virtual-reality-study.html.

Fig. [3.8]: AdobeStock/Gorodenkoff. *Learning with Augmented reality* [digital picture]. https://stock.adobe.com/de.

Fig. [3.9]: Own photograph. Jan De Vylder Office at ETH Zürich, 2023.

Fig. [3.10]: Lehner, Hermann. *ETH Eduspaces, occupancy density of lecture halls and seminar rooms*, 2021, p. 10.

Fig. [3.11]: Sidler, Sarah. *Pub im Chemie-Gebäude der ETH Hönggerberg* [Article]. 2005. https://hoengger.ch/wp-content/uploads/2014/09/050512endfassung.pdf.

Fig. [3.12]: Husse43. *Polylan an der ETH Zürich* [digital photograph], 2018. https://swisssmp.ch/threads/polylan-zürich-2018.8718/.

Fig. [3.13]: ETH Zürich, Raum- und Stundenplanung. *Mietpreise Rektoratsräume*, 2023.

Fig. [3.14]: GTA Institut. *Ausstellungen im HIL Foyer* [digital photographs]. 2021-2023. https://ausstellungen.gta.arch.ethz.ch/veranstaltungen.

Fig. [3.15]: Martani, Claudio, et al. *Flexible Office Space for the Age of Distributed Work*, Netzwerk Stadt und Landschaft, ETH Zürich, 2020, [Digital photograph]. https://www.nsl.ethz.ch/en/flexible-office-space-for-the-age-of-distributed-work/.

Fig. [3.16]: Mateescu, Magdalena, et al. *Evaluation of the Future of Work Survey*, FNHW & ETH Zürich, 2023, [Digital photograph]. https://ethz.ch/content/dam/ethz/associates/services/Anstellung-Arbeiten/Rund_um_die_Anstellung/anstellung-und-arbeit/flexibles-arbeiten/future-of-work/FoW_Umfrage_2022_Auswertung_EN.pdf, p. 21.

Fig. [3.17]: Own representation based on: Mateescu, Magdalena, et al. *Evaluation of the Future of Work Survey*, FNHW & ETH Zürich, 2023. https://ethz.ch/content/dam/ethz/associates/services/Anstellung-Arbeiten/Rund_um_die_Anstellung/anstellung-und-arbeit/flexibles-arbeiten/future-of-work/FoW_Umfrage_2022_Auswertung_EN.pdf, p. 33.

Fig. [3.18]: Own representation based on: Mateescu, Magdalena, et al. *Evaluation of the Future of Work Survey*, FNHW & ETH Zürich, 2023. https://ethz.ch/content/dam/ethz/associates/services/Anstellung-Arbeiten/Rund_um_die_Anstellung/anstellung-und-arbeit/flexibles-arbeiten/future-of-work/FoW_Umfrage_2022_Auswertung_EN.pdf, p. 40.

Fig. [3.19]: Gasser, Bianca. *Workspaces of the Future appear in Oerlikon*, VPPL, ETH Zürich, 2020 [Digital photograph]. https://ethz.ch/staffnet/en/news-and-events/internal-news/archive/2020/12/in-oerlikon-entstehen-arbeitsraeume-der-zukunft.html.

Fig. [3.20]: Gasser, Bianca. *Workspaces of the Future appear in Oerlikon*, VPPL, ETH Zürich, 2020 [Digital photograph]. https://ethz.ch/staffnet/en/news-and-events/internal-news/archive/2020/12/in-oerlikon-entstehen-arbeitsraeume-der-zukunft.html.

Fig. [3.21]: Gasser, Bianca. *Workspaces of the Future appear in Oerlikon*, VPPL, ETH Zürich, 2020 [Digital photograph]. https://ethz.ch/staffnet/en/news-and-events/internal-news/archive/2020/12/in-oerlikon-entstehen-arbeitsraeume-der-zukunft.html.

Fig. [3.22]: Gasser, Bianca. *Workspaces of the Future appear in Oerlikon*, VPPL, ETH Zürich, 2020 [Digital photograph]. https://ethz.ch/staffnet/en/news-and-events/internal-news/archive/2020/12/in-oerlikon-entstehen-arbeitsraeume-der-zukunft.html.

Fig. [3.23]: Open House Zürich, ETH Zürich Octavo, 2021 [Digital photograph]. https://openhouse-zuerich.org/orte/eth-zuerich-octavo/.

Fig. [3.24]: Deplazes, Andrea. *Architektur und Konstruktion, Das Konzept Atelierhaus*, ETH Zürich, HIL E4, 09.11.2021. [Lecture] https://video.ethz.ch/lectures/d-arch/2021/autumn/052-0501-00L/3ea56a4f-0dca-4eae-a4a1-197d98c072c1.html, 00:00:01.

Fig. [3.25]: Atelier Marko Brajovic, *HOM*, 2020, [Digital photograph]. https://markobrajovic.com/en/all/hom.

Fig. [3.26]: Deplazes, Andrea. *Architektur und Konstruktion, Zur Dialektik von Wohnen und Arbeiten*, ETH Zürich, HIL E4, 21.09.2021. [Lecture] https://video.ethz.ch/lectures/d-arch/2021/autumn/052-0501-00L/e2aabea3-4e5d-4e3b-a863-353d05933b20.html, 2:14:39.

Fig. [3.27]: Wäber, Alexander. *Presentation Sektion Portfoliomanagement*, ETH Zürich, Real Estate Management Department, 2023, [Digital photograph].

Fig. [3.28]: Lucarelli, Fosco. *Archizoom Associati, No-Stop City, Internal Landscapes, 1970*, Socks, 2011. https://socks-studio.com/2011/04/19/archizoom-associati-no-stop-city-internal-landscapes-1970/.

Past and current Visions for Campus Hönggerberg

Fig. [4.1]: Own representation based on: Fig. [4.2].

Fig. [4.2]: *Die Planung der ETH Hönggerberg 1957–1990*, disP - The Planning Review, 26:100, 5-20, 1990.

Fig. [4.3]: Own representation based on: Fig. [4.2].

Fig. [4.4]: Own representation based on: Fig. [4.2].

Fig. [4.5]: Own representation based on: Fig. [4.2].

Fig. [4.6]: *Die Planung der ETH Hönggerberg 1957–1990*, disP - The Planning Review, 26:100, 5-20, 1990.

Fig. [4.7]: Own representation based on: Fig. [4.8].

Fig. [4.8]: A. H. Steiner: *Die Entstehung der Hochschulbauten ETH Honggerberg Zurich*, Dokumentation, 1983.

Fig. [4.9]: Own representation based on: Fig. [4.8].

Fig. [4.10]: Own representation based on: Fig. [4.8].

Fig. [4.11]: https://openhouse-zuerich.org/plus/32157-2/ 17.11.23.

Fig. [4.12]: Hanhart, Hans U. / Risch, Gaudenz, *Schweizerische Bauzeitung*, 86. Jahrgang, Heft 21 - 23. Mai 1968.

Fig. [4.13]: Own representation based on: Fig. [4.14].

Fig. [4.14]: *Die Planung der ETH Hönggerberg 1957–1990*, disP - The Planning Review, 26:100, 5-20, 1990.

Fig. [4.15]: Own representation based on: Fig. [4.14].

Fig. [4.16]: Own representation based on: Fig. [4.14].

Fig. [4.17]: Own representation based on: Fig. [4.14].

Fig. [4.18]: *Die Planung der ETH Hönggerberg 1957–1990*, disP - The Planning Review, 26:100, 5-20, 1990.

Fig. [4.19]: Own representation based on: Fig. [4.20].

Fig. [4.20]: KCAPArchitects&Planners, *Gestaltungskonzept Masterplan Science City*, Version 3.0, 2007.

Fig. [4.21]: Own representation based on: Fig. [4.20]

Fig. [4.22]: Präsentation, KCAPArchitects&Planners, *Gestaltungskonzept Masterplan Science City*, Version 3.0, 2007.

Fig. [4.23]: Own representation based on: Fig. [4.20].

Fig. [4.24]: Own representation based on: Fig. [4.20].

Fig. [4.25]: https://www.baumschlager-eberle.com/werk/projekte/projekt/freiraum-fuer-forscher/, 8.11.23.

Fig. [4.26]: https://achimbirnbaum.eu/en/new-student-residences/, 17.11.23.

Fig. [4.27]: Own representation based on: Fig. [4.28].

Fig. [4.28]: https://ethz.ch/content/dam/ethz/special-interest/baug/ivt/ivt-dam/images/maps/masterplan2040-em2n.pdf 17.11.23.

Fig. [4.29]: Own representation based on: Fig. [4.28].

Fig. [4.30]: Own representation based on: Fig. [4.28].

Fig. [4.31]: Own representation based on: Fig. [4.28].

Fig. [4.32]: Jury report, new building HIC, ETH Immobilien, 2020.

Fig. [4.33]: Jury report, new Boulevard, ETH Immobilien, 2020.

ETH Zürich

Chair of Affective Architectures

IEA, D-ARCH, ETH Zürich

www.fonteyne.arch.ethz.ch

ONA - G23

Neunbrunnenstrasse 50 CH-8050 Zürich

Competence Center for
ETH Zurich Spatial Politics