

Forum Chriesbach - "green building"

Dübendorf, Switzerland 



Dübendorf's "green building" through the Zero Emission Concept

Forum Chriesbach is a high-tech research and development center near Zurich, Switzerland. It exemplifies how "green buildings", which consume a minimum amount of energy, water, and other resources, need not conflict with unique ambiance, comfort of the users, nor with architectural expression. Forum Chriesbach is energy efficient and relies on passive energy sources instead of fossil fuels. In fact, it consumes roughly as much heating energy as a normal single-family house although it is forty times larger. It produces a third of its own electrical power needs. Because the building has no conventional heating and air-conditioning systems, CO2 emitted by the building itself during operation is near zero. Forum Chriesbach shows that "green buildings" need not be an exception, but that they can become mainstream, state-of-the-art, contemporary architecture [1]. It exemplifies a good practice example for future building construction in urban areas to promote future sustainable urban development. Once widely adopted, these practices become tomorrow's standards for future low carbon cities around the world.

Country/ City Profile

|  | Country | | City | |
|---|---|---|--|----------------------|
| | Population (2014) | 8,190,229 [2] | Population (2015) | 19,882 [2] |
| | Land area (km ²) | 41,285 [2] | Land area (km ²) | 13.6 |
| | GDP per capita (2014, current international \$, at purchasing power parity) | 57,235 [3] | GDP per capita / GDP per capita at purchasing power parity | n/a |
| | Region | Europe | Region | north side, mountain |
| City's physical geography | Location | <ul style="list-style-type: none"> ✓ Situated in the Glatt Valley, surrounded by mountains about 700 meters high, latitude 47.21° N, longitude 7.56° E (weak air circulation, heat waves, reduce of the seasonal snow cover) ✓ Situated in a hilly, agricultural landscape ✓ Relatively low altitude (436 m above sea level) | | |
| | Climate | <ul style="list-style-type: none"> ✓ Moderate continental (average temperature: from January to February the daytime temperature range is -2 to 7 C°; from July to August the range is 18 to 28 C°) ✓ 1,101 mm/year annual rainfall (Zürich) | | |

Initiating context

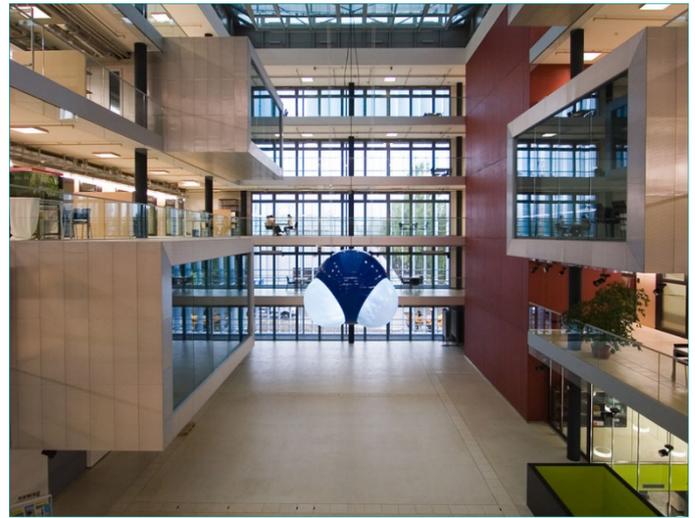
The building sector is key sectors to achieving the EU's 20/20/20 targets. Beyond these targets, Europe also aims to drastically reduce greenhouse gas emission reductions in the building sector by 88 to 91% compared to 1990 levels by 2050 [4].

Sustainable development and architecture are intertwined with other complex issues. To make sustainable construction easier to understand, evaluate, and apply, the Holcim Foundation for Sustainable Construction - which aim is to demonstrate *the important role that architecture, engineering, urban planning and construction have in achieving a more sustainable future* [5] - uses a five-point definition, as follows:

- 1) innovation and transferability - progress
- 2) ethical standards and social inclusion - people
- 3) resource and environmental performance - planet
- 4) economic viability and compatibility - prosperity
- 5) contextual and aesthetic impact - place

These five so-called “target issues” serve as a yardstick to measure the degree to which a building contributes to sustainable development [5]. Forum Chriesbach aims at achieving each of these five criteria [1].

Project description



Source: [9]

The building was built as an administrative and research centre for two research institutes, EAWAG (Swiss Federal Institute of Aquatic Science and Technology) and EMPA (Swiss Federal Laboratories for Materials Science and Technology), with the purpose of testing the technical and architectural limits of a sustainable building. Issues of sustainable development were given high priority right from the start. The major aims were to achieve as high a degree as possible of self-sufficiency in terms of energy supply from renewable energy sources, an efficient use of water, and the use of environmentally friendly materials and landscaping that provides a beneficial environment for people inside. Today, the construction consists of sustainable materials and incorporates facilities for efficient water management, nutrients recovery, renewable energy generation, and passive energy utilisation.

The building itself serves as an ongoing research project. In this way, many findings can be drawn and implemented in future Zero Emission Buildings. Forum Chriesbach is one of the few case studies in Switzerland that tackles all three aspects of the Zero Emission Concept: Energy, Water and Biomass [6].

1 **ENERGY EFFICIENCY** = Forum Chriesbach is a low-energy passive building, in which every part contributes to achieving a comfortable indoor environment, while consuming as little energy as possible. The compact building volume has less surface over which heat loss occurs. The roof and façade are highly insulated and airtight. Thermal bridges are minimized. Large glass areas allow significant solar thermal gain. The façade is ventilated to prevent excessive heat gain in summer. Passive cooling is used in the summer. The louvers, as a schermature, cloak the building in aqua blue. The panes are laminated from two sheets of glass, one of which is printed on the inside with a dot-screen pattern in which the field is light blue and the dots are transparent voids. This pattern admits daylight and reduces the need for electrical lighting while limiting thermal gain during the summer period. The central control system continuously operates all systems for optimum energy efficiency. The combination of all these measures makes a furnace and so conventional air-conditioning system unnecessary. One third of the electricity demand is generated by a photovoltaic system on the roof's edge. The rest part of the roof is constructed as a green roof that supports hearty plant varieties. The humus layer retains rainwater, whereas conventional roofs channel rainwater into sewers and aquifers as directly as possible, which aggravates flooding after storms. The rainwater that escapes the roof of the building is collected in a pond on the site [1].

2 **WATER** = The efficient use of water was one of the main aims in the construction process. Waterless urinals and NoMix toilets ensure minimum water use and the separation of urine from wastewater with solids. Moreover, rainwater is collected from the green roof system and clarified in a pond next to the building. The pond functions as a triple-chamber biological treatment plant. The treated water is used for toilet flushing. When the pond overflows, the water settles in sumps and infiltrates into the soil [6].

3 **BIOMASS** = Men's and women's urine is collected separately by NoMix toilets and waterless urinals. A range of waterless urinals is installed throughout the building for testing and further development. The urine is collected in the basement of the building where there is currently a pilot plant installed with the aim to produce a fertiliser product. Firstly, the urine is nitrified in a nitrification column and secondly evaporated to increase nutrient concentration. The end product contains both nitrogen and phosphor [6].

Implementation process

Project implementation details

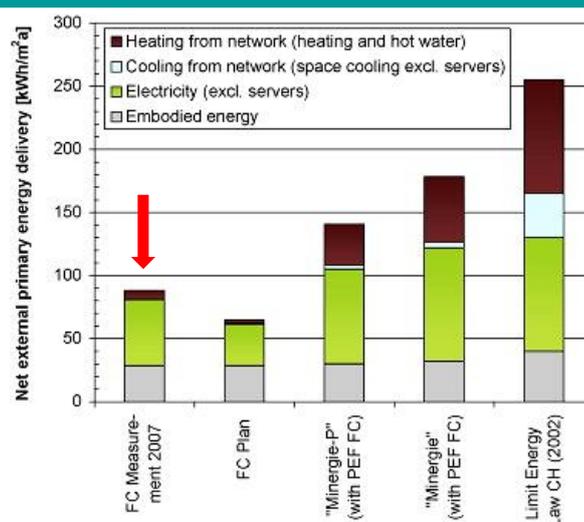
| | |
|----------------------------------|---|
| Process | <p>The Forum Chriesbach was constructed in the years 2004-2006 and has been in operation since June 2006.</p> <p>The steps of development included:</p> <ul style="list-style-type: none"> ✓ 2002: invited competition for project proposals to six planner teams ✓ 2003: decision awarded to the <i>vision</i> project by Team Bob Gysin + Partner BGP ✓ 2004: general contractor mandate awarded to Implenia General Contracting Ltd ; then, excavation begins in July ✓ 2005: the structure was erected in June ✓ 2006: in June, staff moved into Forum Chriesbach and the EAWAG/EMPA day care centre; then, in September there was the official opening ceremony |
| Leadership | The client of the project were EAWAG, that is one of four research institutions of the Swiss Federal Institutes of Technology, and EMPA, the Swiss materials science and technology research institute. |
| Financing | The cost of the project was 29.544 million Swiss francs |
| High-level specifications | <p>From the beginning, EAWAG and EMPA insisted on the implementation of key sustainability criteria for the project. The structural and technical measures were to be innovative, even going beyond the state of the art of the time. This meant:</p> <ul style="list-style-type: none"> ✓ Conserving resources (energy, materials, land, finances) ✓ Striving to achieve the status of a low-energy building ✓ Meeting at least one-third of the building's electricity requirements with a photovoltaic system ✓ Integrating a urine separation system and rainwater recycling ✓ Achieving a compelling cost-benefit ratio |

Results

The construction of Forum Chriesbach not only contributes to the reduction of greenhouse gas emissions, but has several other positive co-effects. Among them are reductions in air pollutant emissions (e.g. NO_x, PM, SO₂, CO, NH₃ etc.), increased health benefits for visitors and users (improved air quality, physical activity), and energy efficiency, with facilities for efficient water management, nutrients recovery, renewable energy generation, and passive energy utilisation. The result achievements have been expressed in absolute numbers after the construction and the use of the building by the community of researchers and engineers, as follows:

Forum Chriesbach (FC) project benefits measuring Primary Energy demand (PE) [1, 7, 8]

| | FC plan | | | FC measurement 2007 | | |
|--|--------------------|-----------------------------------|-----------------------------------|---------------------|-----------------------------------|-----------------------------------|
| | FE ^a | FE ^a | PE ^b | FE ^a | FE ^a | PE ^b |
| | MWh/a ^c | kWh/m ² a ^c | kWh/m ² a ^c | MWh/a ^c | kWh/m ² a ^c | kWh/m ² a ^c |
| Heating from network (heating and hot water) | 23.9 | 2.1 | 2.7 | 64.0 ^d | 5.7 | 7.4 |
| Cooling from network (space cooling excl. servers) | 11.9 | 1.1 | 1.2 | 0.1 | 0.0 | 0.0 |
| Electricity (excl. servers) | 121.0 | 10.8 | 32.4 | 195 | 17.4 | 52.4 |
| Embodied energy ^e | | | 28.6 | | | 28.6 |
| Total | 156.8 | 14.0 | 64.9 | 259.1 | 23.1 | 88.4 |



Source: [9]

Lessons learned

Forum Chriesbach proves many conventional, simple, and forward-looking technologies that can be affordably integrated to achieve good environmental performance without compromising comfort or quality standards.

The building has set standards in the field of sustainable development by doing without conventional heating and cooling systems and consuming very little energy for heating. The building's electricity requirements are met fully from renewable sources. Retaining and using rainwater and returning it to the soil on site are simple but important ways of controlling floods, which are becoming more frequent as permeable soil is sealed beneath buildings and pavement. Thanks to the building's lower operating costs, the slightly higher investment required to secure energy efficiency will be offset in the space of a few years.

The lessons learned from Forum Chriesbach have global ramifications: the project proves that by using conventional materials and known transferable technologies, a high level of performance is not only possible, but affordable and practicable.

With a measured primary energy demand of 88 kWh/m² per year, the building is significantly below the value of 141 kWh/m² per year as required by the Minergie-P standard (the Swiss adaptation of the Passive House standard).

The project exemplifies the idea that the intelligent way to meet energy requirements is not to produce more energy but to consume less [1]. In this sense, it represents a good practice for future low-carbon development in which cities are the natural place to start.

References

- [1] Forum Chriesbach webpage: <http://www.eawag.ch/en/aboutus/sustainability/sustainable-building/forum-chriesbach/>
- [2] World Bank: Data Switzerland: <http://data.worldbank.org/country/switzerland>
- [3] World Bank: GDP per capita, PPP: <http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD>
- [4] Towards Nearly Zero-Energy Buildings Report(2012): https://ec.europa.eu/energy/sites/ener/files/documents/nzeb_full_report.pdf
- [5] Holcim Foundation for Sustainable Construction: www.holcimfoundation.org
- [6] ZEB-ISTIS Integration sustainable Technologies and Infrastructure Systems: <http://www.zebistis.ch/>
- [7] Science Direct website: Eawag Forum Chriesbach - Simulation and measurement of energy performance and comfort in a sustainable office building (2010): <http://www.sciencedirect.com/science/article/pii/S0378778810001957>
- [8] EAWAG FORUM CHRIESBACH - A step towards the 2000-WATT Society:
http://www.eawag.ch/fileadmin/Domain1/About/Nachhaltig/forumchriesbach/dl/step_towards_2000W.pdf
- [9] Photos and images: <http://www.eawag.ch/en/aboutus/sustainability/sustainable-building/forum-chriesbach/> ;
http://www.eawag.ch/fileadmin/Domain1/About/Nachhaltig/forumchriesbach/dl/step_towards_2000W.pdf

Author/ Contact



© FEEM - Fondazione Eni Enrico Mattei

Palazzo delle Stelline
Corso Magenta 63
20123 Milan, ITALY
Tel. +39 02 520 36934
letter@feem.it
<http://www.feem.it>