CSCS
Centro Svizzero di Calcolo Scientifico
Swiss National Supercomputing Centre

ETHzürich

FACT SHEET

Innovative new building for CSCS in Lugano

The construction of a building capable of hosting the nation's supercomputers for the next decades is a highly complex task due to the rapid changes in technology in this field. That is why the defining features of the new CSCS building are innovation, flexibility and ecological sustainability.

Work on the new computer centre in Lugano-Cornaredo began in January 2010. Two separate buildings were erected, one for the offices and one for the supercomputers. The five-storey office block has been built to meet the Minergie Eco standard and offers a total surface area of 2600 square metres. Special care was taken during construction to use environmentally friendly materials. The spacious halls and landings provide meeting areas for the employees and encourage communication, while the white decoration and large windows in the offices provide light-flooded work spaces.

An underground corridor and a footbridge on the first floor lead from the office block into the heart of the new site, the computer building. The inconspicuous, windowless three-storey concrete cube of the computer building is an unadorned structure, but one which, technically and logistically, has been carefully thought through down to the last detail.

CSCS sets new standards

The chief design criterion for the computer centre was that it should be a modular and flexible building and as sustainable and energy-efficient as possible. The parameter by which the energy efficiency of a supercomputer centre is measured is the PUE rating (power usage effectiveness). The target PUE for the new CSCS building is below 1.25. At the time of planning, this rating was extremely ambitious for a supercomputing centre. For this reason, CSCS is today one of the most energy-efficient and ecologically sustainable supercomputer centres in the world. This is the result, among other things, of the use of natural resources such as water from Lake Lugano to cool the supercomputers as well as the building itself in summer. By using the 6 degree cold water from the lake to cool the computers it was possible to forego the installation of conventional power-hungry cooling systems, which would otherwise have accounted for about a third of the total electricity consumption.

In order to achieve the low PUE rating, only those parts of the computer centre's infrastructure which cannot tolerate any interruption to the power supply (such as data storage, networks and the MeteoSwiss computer) are connected to a battery-supported emergency power supply (UPS).

The office block with its distinctive double layered glass facade.
(Picture: Marco Carocari)

UPS systems can suffer losses of up to 30% in the conversion from direct current to alternating current. However, experience has shown that at CSCS power disturbances that require the UPS systems to take over only occur about seven times a year. Should the need for emergency power increase in the future, however, additional flywheels to ride through brief power cuts, and also diesel generators, could be installed at a later date.

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Sophisticated Infrastructure

The basement of the computer building houses the "resource deck" containing the basic infrastructure: 960 batteries for the emergency power supply as well as the electricity and water supply systems. Thick cables deliver the power to the computer centre at a medium voltage of 16,000 volts, where braided copper cables, as thick as an arm, distribute it to the twelve currently installed transformers.

The transformers convert the power to 400 volts, before it is taken via power rails to the middle floor, the "installation deck", and finally from there to the supercomputers. The existing power supply allows the computer centre to operate computers with an output of about 11 megawatts and this could even be extended to operate up to 25 megawatts.

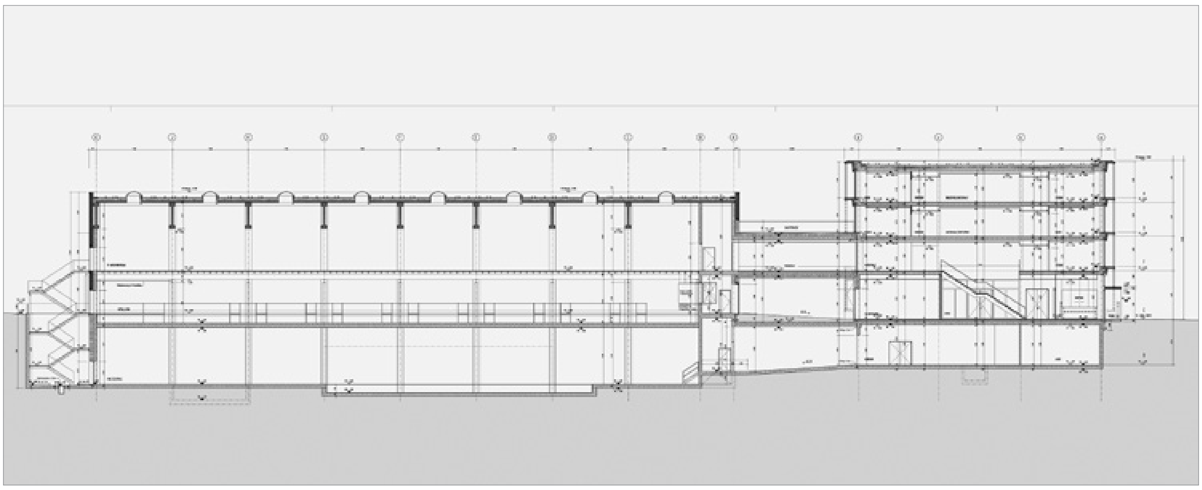
The lake water pipe, measuring 80 centimetres in diameter, enters the building on the south side. Alongside it, a pipe of the same size leads back to the lake. Between the incoming and outgoing pipes, there is a sophisticated cooling system in operation: the lake water and the internal cooling water circuit meet in heat exchangers which are as tall as a person. There the low temperature of the lake water is transferred to the internal cooling circuit. This delivers water at about 8 or at most 9 degrees to the supercomputers to cool them. By the time the water has passed through this first cooling circuit, it is eight degrees warmer. However, this water is still cold enough to cool the air in the housings of lower-density computers and hard discs. To this end, it is sent through another heat exchanger that is connected to the medium-temperature cooling circuit. This allows one pumping operation to supply two cooling circuits that cool several systems. This, too, saves energy.

The computer building (left) and the office block (right) are connected by a bridge and an underground tunnel. *(Picture: CSCS)*

A separate storey instead of a raised floor

From the "resources deck", the processed power and water are sent to the "distribution deck", the installation floor located directly above. In most conventional computer centres, the installation deck consists of a raised floor measuring 40 to 60 centimetres in height through which kilometres of cable are fed. The cabinets for the power distribution units (PDU) are located in the computer room and so limit the options for installing supercomputers.

In order to avoid this limitation in the new CSCS building, the raised floor has been replaced by a five-metre high storey which houses the entire technical infrastructure, also called the secondary distribution system. The decision to opt for this construction was made on the basis of experience in the previous computer centre in Manno where the raised floor was barely able to accommodate the installation of new computers.



The new man-high structure is clearly laid-out and allows easy access to the technical infrastructure. This is also where the fuse boxes and power distribution boxes are located next to the hydraulic system for the secondary water distribution system, instead of in the computer room. The equipment stands on steel mesh platforms 90 centimetres high, to protect them in the event that the water cooling system should ever spring a leak.

Five kilometres of power tracks, arranged in three layers, crisscross the room. These carry the huge power supply and communication cables to the computers. The power supply to the supercomputers is housed in black cabinets, whilst the infrastructure protected by the emergency power supply is in orange cabinets. This allows the technicians to take precise action in an emergency. The floor on which the supercomputer infrastructure stands is as "permeable" as possible, to allow for the supply of power and water, yet it can also support a weight of several tonnes. It consists of square 4,5 centimetres thick floor tiles, which in conventional raised floors are supported by pedestals. In the new CSCS building, they are supported on a special structure consisting of three layers of steel girders of different thicknesses, forming a mesh on which the floor tiles rest. The tiles, measuring 60 x 60 centimetres, can be lifted wherever this is required so that cables from the "resources deck" to the machine room can be laid. This allows for maximum flexibility when it comes to installing the computers.

Flexible machine room

The construction of the machine room, which measures 2000 square metres, was designed to minimise restrictions to the installation and operation of supercomputers in the future. That is why there is not a single supporting pillar or any partitioning. This is made possible by the purpose-made concrete girders, 35 metres long and weighing 50 tonnes, which support the ceiling. Numerous tubes, which are part of an early smoke detection system, hang from the ceiling. They are fitted with highly-sensitive fire detectors that constantly extract air from the computers in order detect a smouldering fire at an early stage.

The building has been planned to be modular in structure, allowing as much flexibility as possible in developing it and adapting it for subsequent technologies. A hoisting crane, with a weight-bearing capacity of up to 10 tonnes and the ability to reach all storeys of the computer building from the delivery area, ensures that any later modifications to the building can be made without difficulty.

Left: Cross-section of the three-storey computer building and the five-storey office block.

The three floors of the computer building. From bottom to top: resource deck, installation deck, machine room. *(Picture: Marco Carocari and CSCS)*

An overview of the machine room. *(Picture: CSCS)*

HPCN-strategy made the project possible

The new CSCS building is part of the national High-Performance Computing and Networking Strategy (HPCN) that was passed by the Swiss Federal Council and Parliament in 2009. The design specification set by the ETH Zurich Executive Board was that the new computer centre should be able to accommodate the supercomputing infrastructure for Swiss science for the next 40 years. The new building should ensure that even the supercomputers of the future can be operated to full capacity and in an energy-efficient manner at the Swiss National Supercomputing Centre. The overall aim of the HPCN strategy is to ensure that high-performance computing, an increasingly important technology for many scientific fields, is made available to all Swiss researchers.

The cost to the federal state of the new building enabled by the HPCN strategy (including the cost of the lake water cooling system) was estimated at 67.5 million Swiss francs. In addition, the canton of Ticino contributed 5 million Swiss francs while the city of Lugano granted a 40-year land lease for the plot of land in the Lugano area. The city of Lugano also enabled the realisation of the lake water-cooling system. In addition, ETH Zurich invested in an extension to the computer building for its own purposes.

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