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North-east façade.

IUCN headquarter in Gland, Switzerland – an example for efficient energy design

The IUCN, as an international organisation which is active all over the globe to preserve the natural environment has set a high target for his extension of the Swiss headquarter in Gland.

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Based on the wish of IUCN to crate a showcase of sustainable construction and high efficient building technology, the interdisciplinary team went to work in 2006. The building finally was inaugurated in the Spring of 2010. It complies with the Minergie-P-ECO and is aspiring the American LEED Platinum label. The key factor of success for the realization was the interdisciplinary collaboration. The close collaboration between architects and specialized engineers has made it possible to conciliate aesthetics, energetic performance and high flexibility for occupants with a very tight budget.

Interdisciplinary design – a key factor for an efficient building

The starting point for a successful energy-efficient structure is an architectural concept which takes into accounts passive solar heat gains and thermal losses. An optimized primary energy balance has been sorted through an iterative process changing the thermal performance of the envelope as well as the fraction of glazing and opaque wall parts and their thermal performances. The result of this optimization can now be identified with the work done: a relatively low rate of glazing compared to the surface of facades, a wall thickness of 35 cm, a high performing triple glazing as well as outside corridors for sun protection in summer and as emergency exits for users in case of fire.

A key element of this optimization was the glazing, which strongly influences the cooling needs and the comfort of users. The 25% glazing ratio of the facade can limit power peaks. To improve management of natural lighting without risking overheating due to solar radiation, movable blinds that are closed from bottom to top were established.

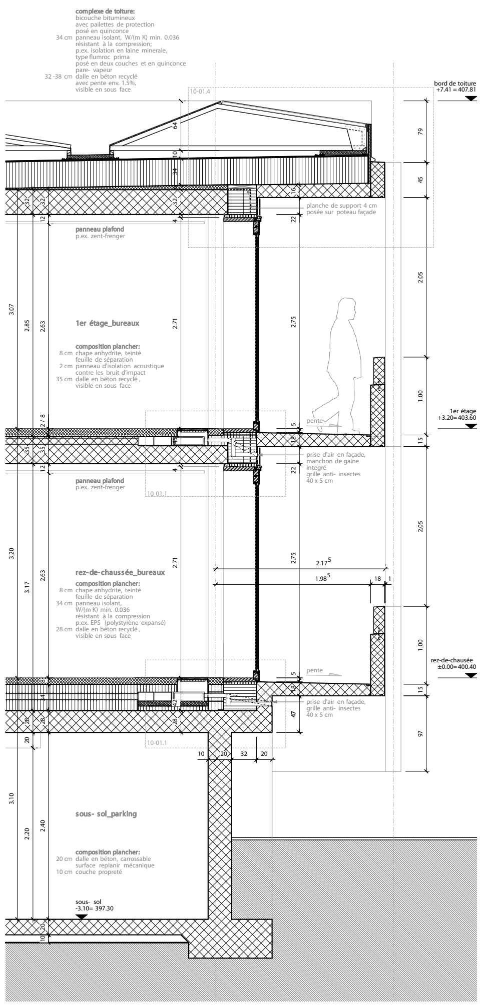

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Figure 1. Principle section.

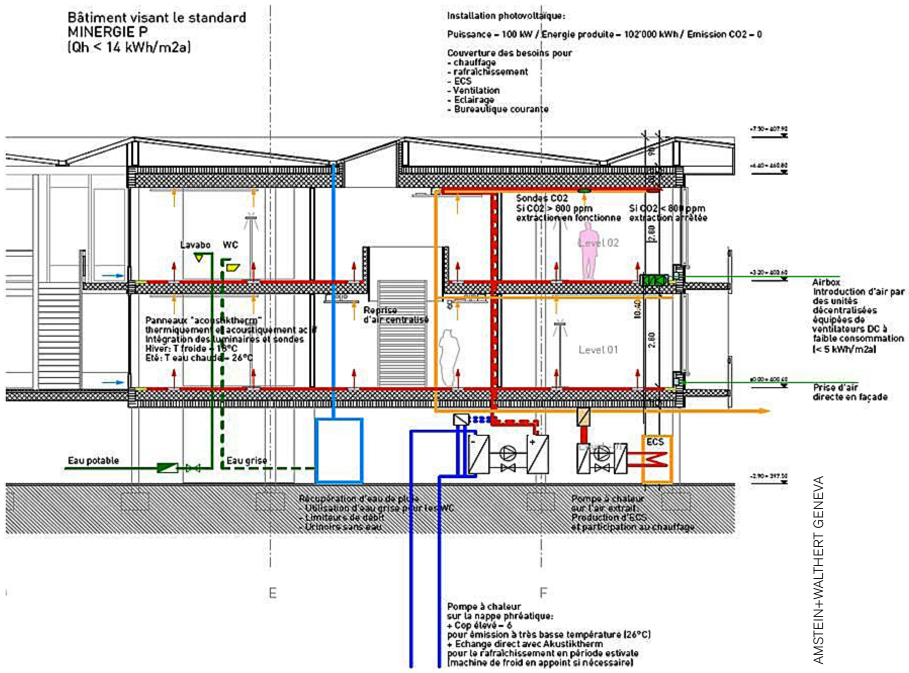

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Figure 2. HVACS diagram.

Energy from the basement and sun

Thanks to the thermal performance of the envelope, the heating need is very low. There is still necessary to heat the supply air of ventilation and domestic hot water. Requirements for space heating are secondary. Mainly because of an administration-bent working, the cooling need is by contrast predominant. It was then necessary to use a renewable source for cooling energy. Geothermal energy provided the answer. With a field of geothermal wells of a depth of 150 meters, 30% of cooling needs can be met by passive cooling. Cooling energy is produced by the reversible heat pump only when the free-cooling reservoir is exhausted. Through the dissipation of heat in the ground, in the second part of the summer heat warms the ground in order to optimize the performance of the heat pump in the following winter. In parallel to the heat pump connected to the geothermal probes a heat pump on the exhaust air was installed to preheat the air of the decentralized air intakes. This heat pump is also reversible and can cover smaller cooling needs of the fan coils without disrupting the geothermal free cooling storage.

A 1 400 m² photovoltaic installation on roof covers the annual electricity needs. Seasonal overproduction is fed back into the electrical grid.

Demand controlled ventilation

Given that the occupation of areas of work is very varied, constant flow ventilation would consume too much electrical energy and a traditional VAV facility would be too expensive. The adopted solution consists of small floor mounted decentralised outdoor air units contributing independently to the ventilation and thermal comfort of users. For the entire administrative area, except for large conference rooms, decentralised units have been positioned close to the facades at floor level. These units (marked as AIRBOX in **Figure 2**) are equipped with an air intakes from facade, a filter unit, a fan and a heating/cooling coil. The units operate only with outdoor air and there is no air circulation. They are controlled according to CO_2 in the room air. The CO_2 sensor is located at the exhaust damper, integrated into a multifunctional panel mounted on the ceiling. Each ventilation unit is connected to an exhaust damper, both attributed to one facade frame. This system avoids a complete supply air ductwork. It allows a much easier routing for technical installations. On the other hand, an air quality management based on demand is possible. If the CO_2 is high, the ventilation starts and if the air is clean again, the fan stops. If users are not present, two air flushes per day allow to keep a minimum fresh and good air quality.

The multifunctional ceiling panel, serving at the same time as thermal activation of the ceiling, as acoustic element and as light fixture, also includes an extract air terminal. In this solution, the activation of the thermal storage is through profiles/pipes fitted with hydraulic circuits spreading heat in both directions: on the surface of the panel for a direct exchange and to the concrete surface to activate the inertia of the concrete flagstone, **Figure 4**.

For efficient operation, 50% of the flagstone had to remain as raw concrete. Through the activation of the flagstone, the peak power was reduced by about 35%. This had a positive impact on the design of plants and helped to control investment costs.

Automation of the next generation

At the level of the building's automation, a new technology has found its application. The management of decentralized units and the recovered air dampers and

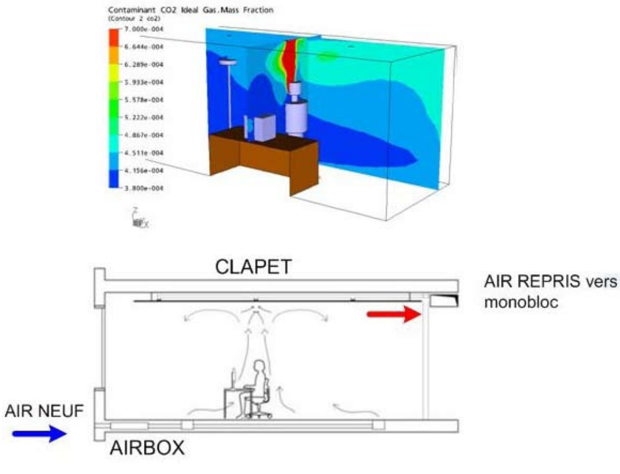

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Figure 3. Ventilation, heating and cooling concept.

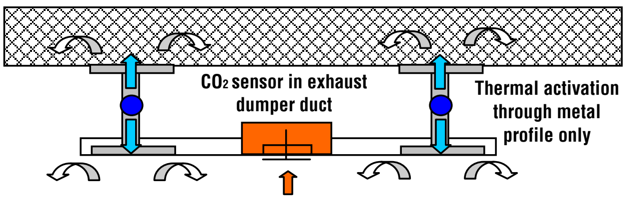

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Figure 4. Ceiling panel for heating and cooling, with integrated extract air terminal and lighting.

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Figure 5. Photo of a multifunctional ceiling panel.

CO_2 sensors are driven by Digitalstrom. This technique uses the electric power for the transmission of information and makes the installation of a conventional bus obsolete. Given that the implementation of this system was a world first and it was necessary to consider some "teething troubles", the system was limited to the installation of ventilation of the offices. For all other HVAC systems, lighting and blinds, a traditional LON system has been implemented.

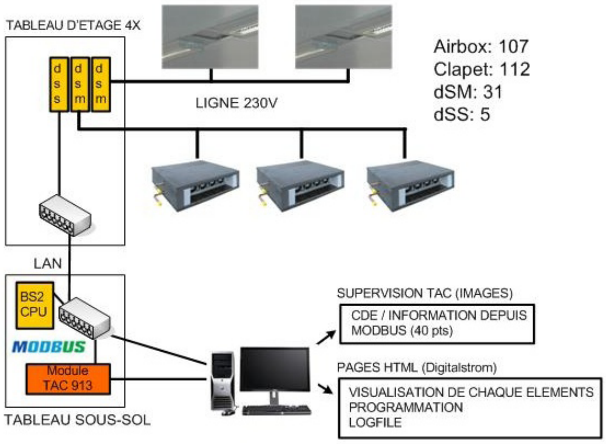

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Figure 6. Digitalstrom typology.

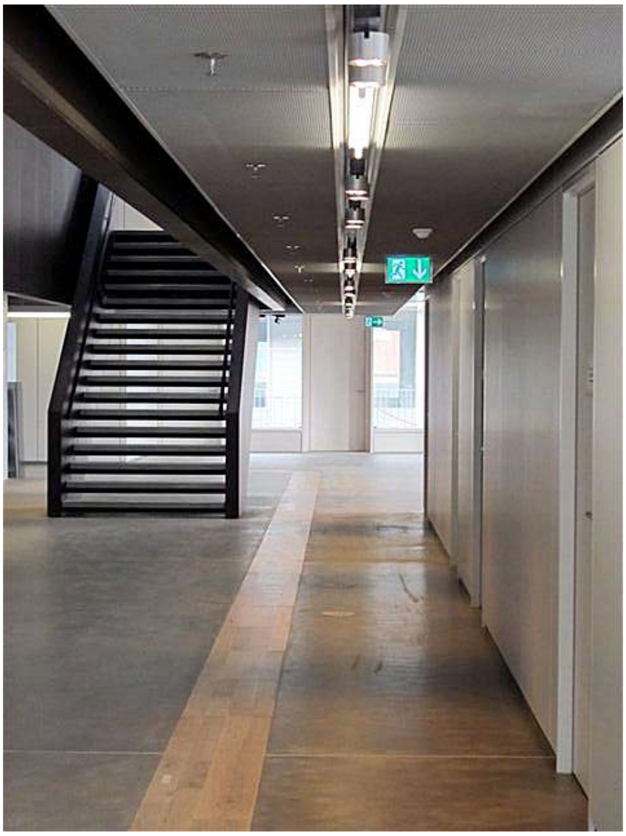

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Figure 7. View from inside the building.

Maximized day lighting

The lighting concept supports the use of daylight. Each workplace is located in front of a large bay window. The windows are generously sized, with 3.2 m² per workplace. The depth of the premises is 5 meters only. Most of the time work in day light is thus possible. Thanks to architectural measures, workplaces are protected from the solar glare. As light source, fluorescent tubes of TL5 type, with reduced mercury levels, were installed. The concept has been supplemented by LEDs. In offices, fluorescent tubes are used as basic lighting and LED table lamps serve as support lamp at the level of workplaces. In the corridors, the LEDs are used as decorative lighting and create a pleasant atmosphere. The meeting rooms are equipped with HIT lamps complemented by LED lights for atmosphere. With this combination of lighting, the specific power amounts to only 6.6 W/m². Only 6 different types of light fixtures are installed throughout the building enclosure and, thus, maintenance costs and servicing are considerably limited. Movement detectors and light intensity can further reduce consumption to a minimum.

Exterior lighting was kept to a minimum to avoid light pollution. The idea of a night enhancement of the façade and of the illumination of the natural garden has been abandoned.

Efficient water management

A system of efficient water management is based on three axes: the first is the reduced consumption of drinking water because it contains a significant proportion of energy for transportation and treatment. Drinking water is distributed in the kitchen for water fountains located in the building as well as in the wash-basins of the lavatory. The second axis is to use gray water for toilet flushing and garden irrigation. This water, collected on the roof, is carried in a tank of 70 m³. The overflow is led directly into the natural garden, and, in fact, into the groundwater. The last axis is the optimization of drinking water. Water flows in the taps were limited and the taps in the toilets were equipped with infrared detectors. Result of this concept: a saving of water of 4 000 litres per day.

First performance review after 8 months

As the real optimization phase hasn't begun jet, the only figures available today are the total electricity consumption for the new building. Compared to the dynamic building simulation including all electrical energy con-

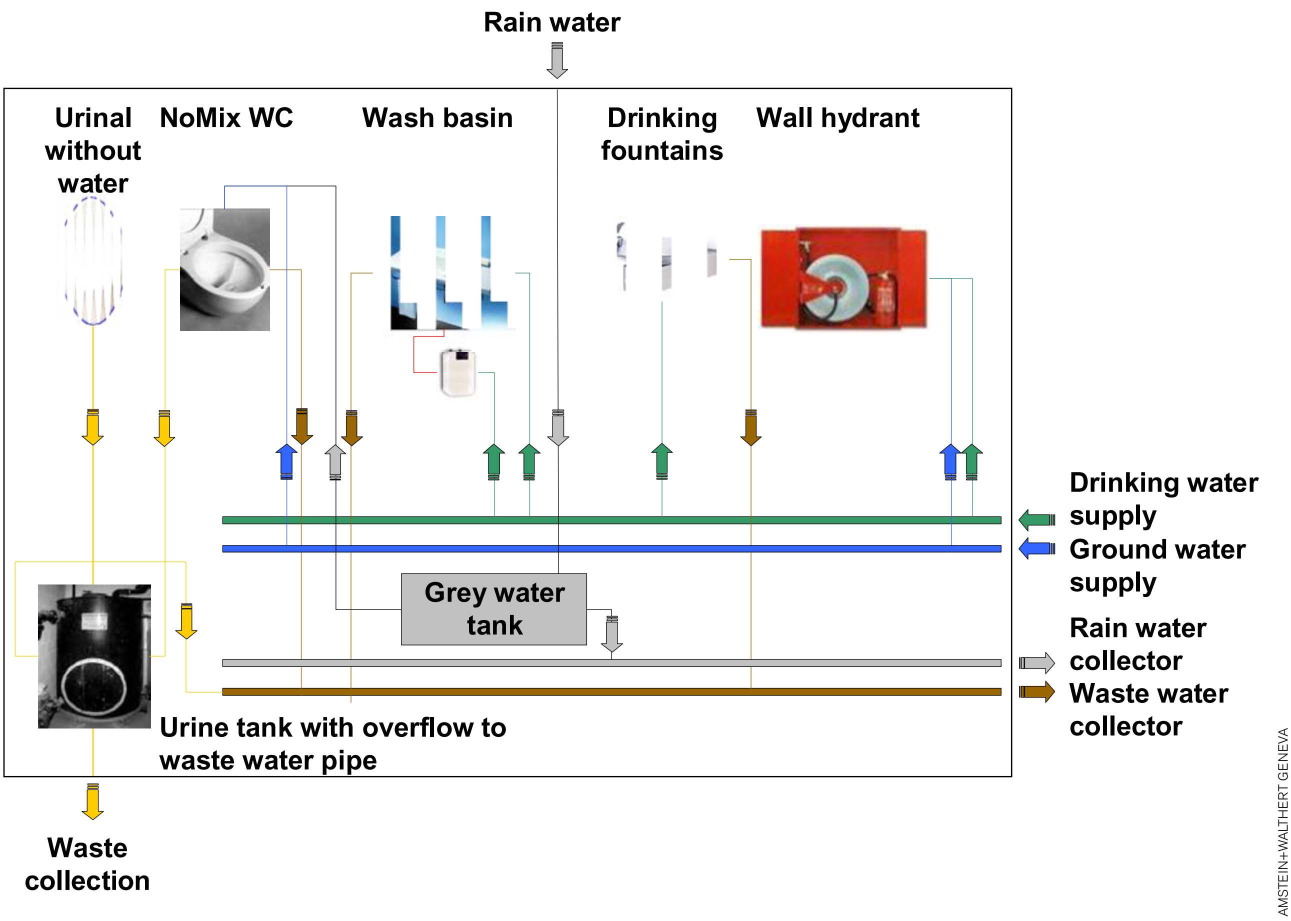

Figure 8. Principle of water management.

suming facilities, the one year consumption hit the simulation target quiet well. Breakdown of the simulated energy performance is shown in **Table 1**.

For the first year, the calculated values will overrun the calculated electrical consumption by 10%. This might be optimistic because the building is today occupied by 90%. In addition to that some troubles with the ventilation control system have been fixed during the last month. Focused on this early result, the analysis shows big discrepancies during October and November. Further investigations are necessary to improve the whole system. The goals for the next step is to break down the comparative results and analyze consumer one ▶

Table 1. Simulated energy performance of the building. All specific values are per net floor area.

	Net delivered energy use kWh/(m² a)	**Primary energy factor** -	**Primary energy use** kWh/(m² a)
Space, water and ventilation heating, electricity to heat pumps	6.0	2	12.0
Cooling, electricity to heat pumps	6.7	2	13.4
Fans (HVAC)	5.3	2	10.5
Pumps (HVAC)	2.8	2	5.6
Lighting	16.3	2	32.6
Appliances (plug loads)	26.8	2	53.6
PV power generation	-30.9	2	-61.8
Total	**33**		**66**

Inner courtyard of the building.

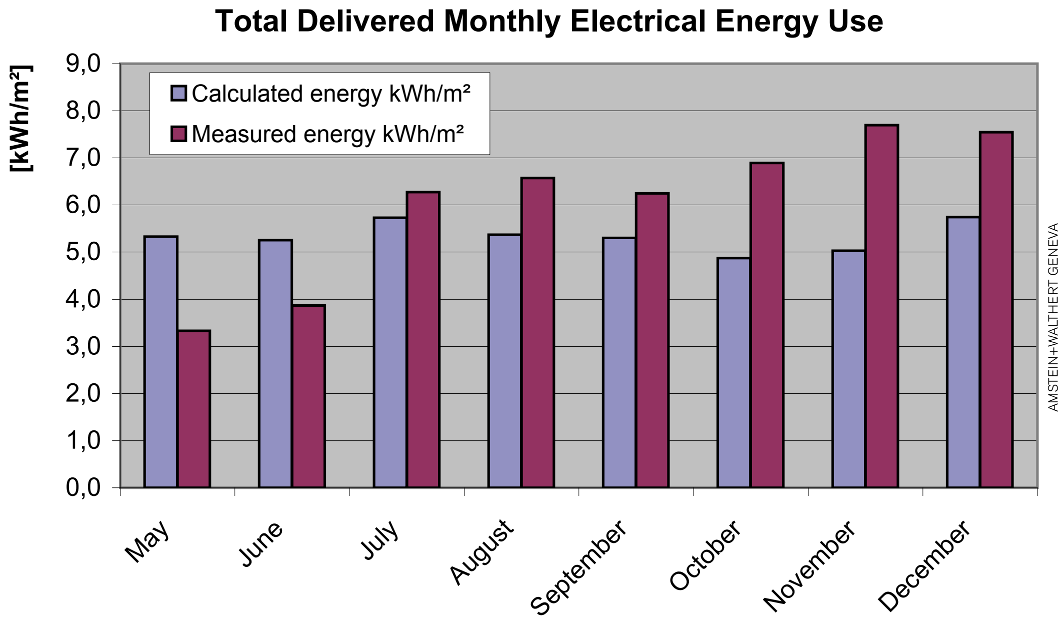

Figure 9. Comparison of calculated and measured delivered energy use.

A photo from construction phase.

PV panels installed on the roof.

▶ by one to check if set points, operation schedules and the sensor technique is running correctly. Also user behaviour need's to be analyzed.

Even with the analysis not finished jet, the result of energy performance for the IUCN extensions building proves that the annual energy use is able to hit the MinergieP target.

In a general way, the building designed according to Minergie Standard shows a coherent behaviour between design parameter and real measurements. It is valid for peak power demand for heating and cooling and lighting power. On the other hand the calculated energy use doesn't fit that exactly to the real building consumption. The main reason for that is that standard calculation does not correspond to real behaviour and occupation scheduled. Variation from +/- 20% can be expected. Important for high performance buildings is that the variation between calculated and real measures varies in the same percentage range as in normal buildings. Based on a low net energy need for heating of 22 kWh/m² per year, the result can vary of 4.4 kWh/m². On this low level of energy consumption it is more than comprehensive that the user behaviour has a higher impact than on normal buildings. In general MinergieP buildings have kept their premises in terms of energy savings if used as designed. 3E

Key figures	
Net floor area	4 530 m²
Volume of building according to SIA 116:	31 700 m³
Volume of building according to SIA 416:	26 115 m³

Technical concept of nnZEB:

- Optimized building envelope with **25% glazing ratio**
- External blinds for effective solar protection
- U value for exterior walls of 0.1 W/(m² K), for walls with triple glazing of 0.5 W/(m² K) and for windows 0.7 W/(m² K)
- Decentralised ventilation units for supply air with facade intakes
- Central exhaust units on the roof with heat recovery with reversible exhaust air heat pump
- Ceiling panel for heating and cooling, a multifunctional panel with integrated extract air terminal and lighting
- Boreholes for free cooling (30% of the cooling need)
- Ground source reversible heat pump for heating and cooling
- Rain water collector and grey water system

Annual total delivered electrical energy use (including user appliances)	289 MWh
Electrical output of photovoltaic system:	
PV installed power	150 kWp
Produced energy (calculated)	140 MWh/a
Delivered energy use (all electricity, including user appliances)	64 kWh/(m² a)
On site electrical energy production with PV	31 kWh/(m² a)
Net delivered energy use	**33 kWh/(m² a)**
Primary energy use	**66 kWh/(m² a)**
Saving of drinking water	around 4 000 litres a day