Berlin Bauen

Senatsverwaltung
für Stadtentwicklung

Institute of Physics in Berlin-Adlershof

Urban Ecological Model Projects

Hochschule Neubrandenburg
University of Applied Sciences

The Building

Address	Berlin Adlershof, Newtonstraße 15, 12489 Berlin
History	The building resulted from an architectural competition held in 1997
Start of the construction	1999
Architects	Georg Augustin, Ute Frank, Berlin
Landscape Architects	Stefan Tischer and Joerg Th. Coqui, Berlin
Builder/Owner	Land Berlin, represented by the Senate for Urban Development, Department V. The project received financial support from the Federal Republic of Germany as a joint initiative for the construction of universities.
Construction completed	2003
User	Humboldt University Berlin
Usable floor area	9,700 m^2
Total ground surface area	19,000 m^2
Total interior volume	74,000 m^3
	Received the Berlin Architectural Award in the year 2003

Photographer: Hans-Joachim Wuthenow

Model from the architectural competition held in 1997

The Institute of Physics of the Humboldt University Berlin is an exceptional project of ecological urban development featuring various innovations of sustainable construction. The focus of the project is on a concept of decentralised rainwater management, building greening and elements for cooling and ventilation.

Rainwater is stored in cisterns and used to irrigate a façade greening system and to generate evaporative cooling in air conditioners. Extra water is collected in a pond in the building's courtyard allowing the water to either evaporate or drain into the ground.

The Project

Devices for measuring potential evaporation

Within the framework of the Berlin Programme for Urban Ecological Model Projects commissioned by the Berlin Senate for Urban Development, a working team consisting of experts and scientists from the TU Berlin, the Humboldt University, and the University of Applied Sciences Neubrandenburg has scientifically monitored and evaluated the project.

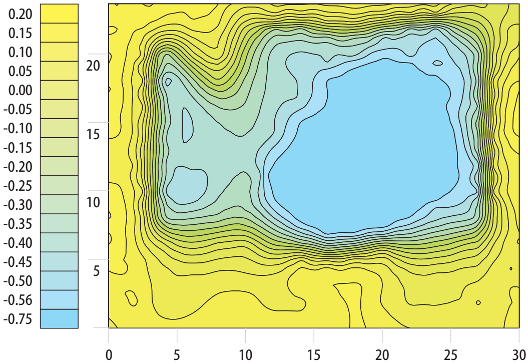
This research is designed to draw up recommendations for an optimal and economical management of the building's mechanical systems with an emphasis on an innovative and sustainable use of the resources water and energy as well as on the reduction of operating costs.

The project includes among other things an ongoing monitoring of the water consumption of different plant species of the façade greening system and of resultant evaporative cooling along with its effects on the overall energy consumption of the building. In this project, irrigation is controlled and monitored by an internet-assisted computer system. Temperature and radiation measurements assist in analysing economic and ecological effects of these systems. In addition to the monitoring, this model project is integrated into research projects designed to evaluate energy concepts for office buildings in the context of studies being done by the Institute for Building and Solar Technologies at the Technical University of Braunschweig.

The monitoring, evaluation, optimisation and documentation of project-related experience should provide basic conditions for the long-term implementation and further development of innovative and economic technologies. Practical results and user-oriented findings are worked out and documented for future projects to support their design, construction, operation and maintenance.

Decentralised Rainwater Management

Landscape modelling to determine remaining storage capacity with respect to water level



Transfer of rainwater from the cisterns

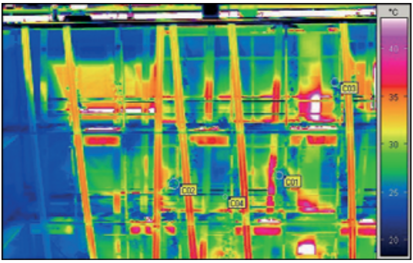
The building of the Institute of Physics is not connected to wastewater or rainwater sewers. One of the main goals of the decentralised rainwater management is the retention of rainwater. Rainwater is stored in 5 cisterns in two courtyards of the building, and primarily used for the irrigation of the façade greening system and the adiabatic cooling. Storm water events with heavy rainfall are managed with an overflow to the pond in one of the courtyards, from which the water can evaporate or drain into the ground. To protect the ground water from pollution, this drainage is only allowed through surface areas with vegetation. Some of the roof surfaces are extensively greened.

Roof and façade greening

Passive Building Air Conditioning

Impermeable surfaces such as roofs and streets influence the urban microclimate by impacting on the radiation or energy respectively. As a result, ambient temperatures surrounding buildings also rise and lead to a room climate of discomfort or increased energy use for air conditioning. One solution to this problem is to green their façades and roofs, thereby consuming heat energy through evapotranspiration. Measurements taken at two roofs in Berlin-Tempelhof show that 58% of the radiation balance can be converted into evapotranspiration during summer months.

In comparison, non-greened roofs can convert 95 % of the radiation balance into heat. Façade greening can even more significantly impact on a building's energy balance. The average evapotranspiration rate between July and August was between 5.4 and 11.3 millimetres of water per day depending on the respective floor, i. e. an average cooling value of 157 kWh per day.



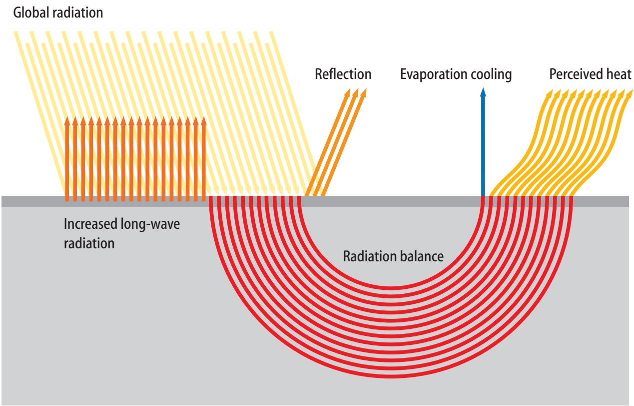
Infrared image with midday summer temperatures (red = warm, blue = colder façade areas)

Façade greening

Daily Energy Balances on Average

Comparison of greened and non-greened roofs

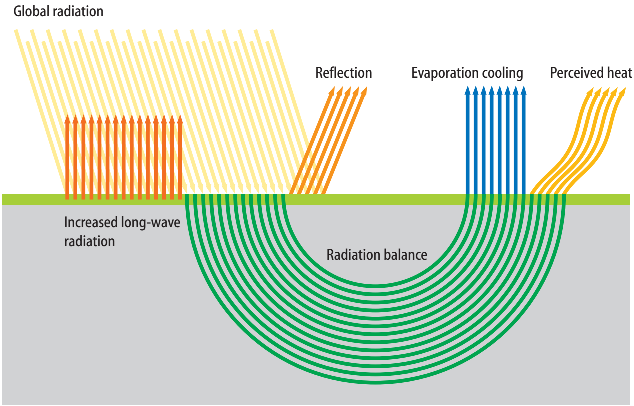
Bitumen roof



Primary factors:

- Surface colour (Albedo)
- Surface heat capacity
- Exposition

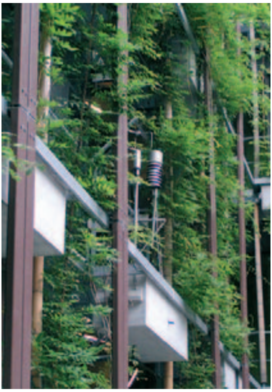
Extensive roof greening



Primary factors:

- Water storage capacity of substrate
- Exposition
- Coverage of vegetation

Green Façades



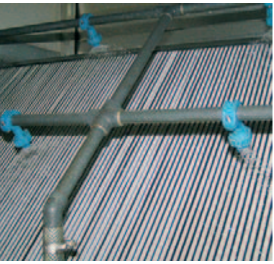
Green façades are expected to provide an active solar shading system. As a "side effect" they illustrate the changing seasons. Ten types of climbing plants have been planted in 150 planters on nine different building façades. Façade greening is closely related to the effort of optimising energy efficiency of the building. Plants provide shade during summer, while in the winter the sun's radiation is able to pass through the glass front. The greening also harnesses evapotranspiration to improve the microclimate inside and around the building.

Planters with substrate on the façade

In selecting the climbing plants an emphasis was placed on types that can grow in planter boxes under extreme conditions. Of the various plants tested the Wisteria sinensis has proven to do the best. In addition, a special system of irrigation and different substrates have also been applied and studied. A factor in the selection was an adequate capillary climbing capacity. A layer of insulation was provided to some of the planter boxes to compensate for large shifts in temperature and to help protect against very low winter temperatures. A comparison with boxes without insulation revealed significant differences in the growth of plants according to their location.

Adiabatic Cooling Systems

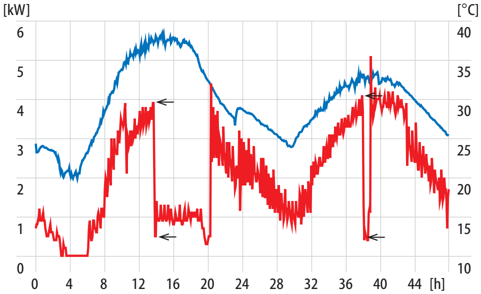
Interior View



During summer months, rainwater is used for air conditioners in the building of the Institute of Physics. For the process of adiabatic cooling, rainwater is sprayed on the building's exhaust air whereby fresh air entering the building is cooled through a heat exchanger. The use of rainwater means to save both drinking water and waste water.

This process of air conditioning of a building is effective in cooling incoming air to a temperature of 21–22 °C with outside temperatures of even up to 30 °C, without having to revert to technical cooling systems.

Energy Consumption in Interior Courtyard



Outside Temperature
System 4
← Energy Consumption reduced > 67 %

Air conditioning system with adiabatic cooling

Initial Results

Rainwater pond in interior courtyard

Façade greening

Evaporation of water is an economic and effective means for the air conditioning of a building. The evapotranspiration of one cubic meter of water produces an evaporative cooling with a value of 680 kWh. Adiabatic cooling systems can practically be seen as substitutes for conventional air conditioning technologies. Synergies can also be achieved by using rainwater in decentralised systems, for example rainwater can be used for both irrigation and adiabatic cooling.

Greening a building's roof and façades, one of the passive cooling systems, results in significant additional evapotranspiration. It has a high potential of reducing the building's surface temperatures thereby improving the microclimate inside and around the building.

The Field of Ecological Building in the Berlin Senate for Urban Development

Building requirements are becoming increasingly complex. Current building design calls not only for accepted technical standards, but also for an optimisation of a variety of objectives, some of which conflict with each other.

The main objective is to organize the planning, building and management of projects to ensure that

- environmental and natural resources are conserved,
- the highest standards possible are reached with regard to environmental and social impacts, and
- sustainable living and working conditions are achieved and maintained.

The drawing up of standard guidelines for the design, construction and management of public as well as publicly funded building projects is also aimed at

- reducing costs of design and building, and
- minimizing operating costs such as those for water and energy as well as building life cycle costs.

Over the last few years, the Programme for Urban Ecological Model Projects has entailed a further development in the field of residential and urban construction, led to new technologies as well as to the establishment of guidelines for public and publicly funded construction projects.

Location at the Adlershof Research Centre

Links:
www.stadtentwicklung.berlin.de/bauen/oekologisches_bauen
www.gebaeudekuehlung.de

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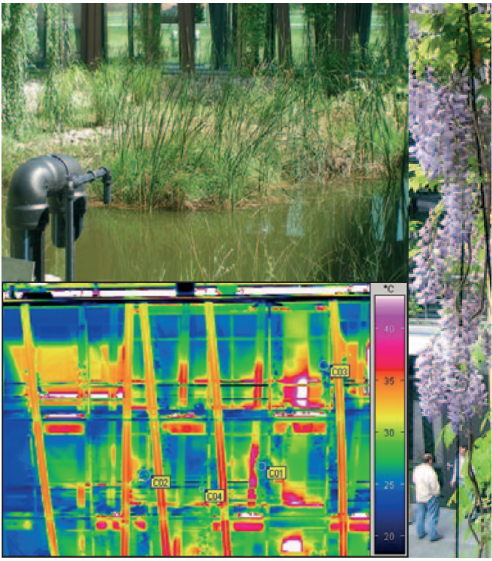

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