TRIER UNIVERSITY
OF APPLIED SCIENCES
Umwelt-Campus Birkenfeld
Environmental Campus Birkenfeld

Environmental Campus

Experience Green Technology

Contents.







Foreword. Zero -Emission.

Birkenfeld Environmental Campus - one of the greenest in Germany.

"Where is Germany's greenest university?" In answer to this question, put to students by Utopia AG in 2011, the Environmental Campus in Birkenfeld was ranked a sensational first. Utopia AG commented: "It is an impressive experience to see how sustainability is actively lived and practised on this campus."

This brochure contains a brief overview of the technical facilities which make Birkenfeld Environmental Campus unique. It answers questions such as how the campus makes use of solar energy or how it meets its heating requirements.

Every technical installation is designed as a step towards implementing the green campus concept based on zero emissions. Both students and casual visitors should experience first-hand how sustainability works. The various measures in place range from simple motion sensors to a comprehensive daylight regulation system, or from direct use of rainwater to waterless urinals. Together, all the technology installed ensures that the campus can cover 100% of its basic energy needs from renewable sources.

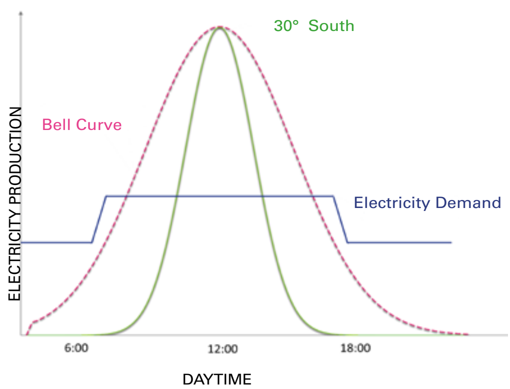
The communications centre built in 2012 according to passive-house standards deserves special mention, as it regulates its own heating and ventilation requirements automatically and thus serves as a showcase for sustainability in practice.

Photovoltaic Technology - Electricity from Light.

The Environmental Campus is exposed to about 1,000 kWh/m² of sunshine per year, making it suitable for the use of photovoltaic technology. In addition, it has large expanses of roof surface oriented favourably towards the sun and there are no other buildings or trees in the vicinity which could cast shade. Not only the roof areas, even the facades of the connecting passageways were incorporated into the photovoltaic system and used to generate power.

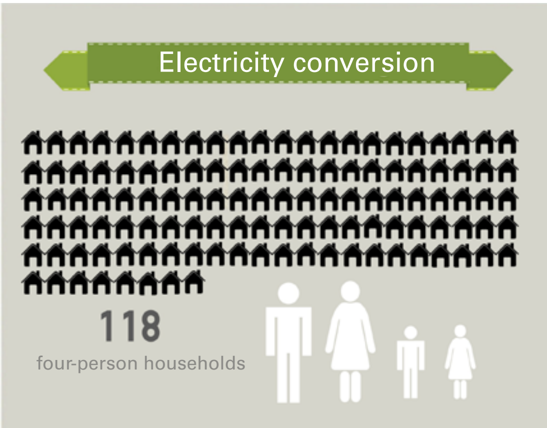
The Environmental Campus consumes approx. 1,000 MWh of electricity annually. As the photovoltaic installation on the rooftops generates approx. 520 MWh annually, it could actually cover approx. 52% of the total amount required if it were fed directly into the campus grid. However, during the planning phase the decision was taken to feed this electricity into the public grid instead, as the then feed-in tariff determined by German renewable energy legislation meant this option made more economic sense at that time.

DAILY PRODUCTION PV



If, on the other hand, the electricity generated on campus were fed exclusively into the campus grid, then the situation could arise where the demand for power is lower than the amount produced and the surplus could not be consumed. However, as the electricity generated on campus is fed directly into the public grid, it is enough to satisfy the power requirements of 118 households of four based on an average annual consumption of 4,400 kWh per household.

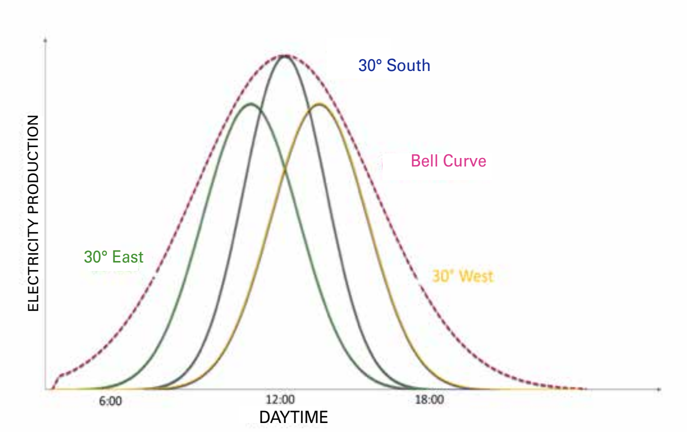
Also worthy of note is the fact that approx. 372 t of CO_2 emissions are saved annually due to the PV installation. In respect of the households just referred to, this means that they could drive the equivalent of approx. 25,000 km on average per year with neutral CO_2 emissions. The PV installation itself comprises 6,494 polycrystalline, monocrystalline and thin-film solar panels covering a total area of two-thirds of a football pitch. The nominal power of the installation is 530 kWp. The direct current generated by the solar modules is transformed into alternating current and then fed into the public electricity supply grid. In order to maximize the yield, the orientation of the solar modules varies between east, south and west.



The orientation of the modules is adjusted to follow the sun. As the diagram shows, the rate of power production (red curve) is thus higher for longer during the day as the solar modules do not all face south (yellow curve). As a result, the regular power needs of the Environmental Campus (blue curve) can be better supplied by the PV installation.

The solar modules installed on the facades of the connecting passageways cover an area of 370 m² and generate 18.6 kWp. This electricity is fed directly into the campus grid, thus contributing to the supply of the campus' own demand. Approx. 6,000 kWh of electricity are generated by the facade modules per year, the equivalent of the average annual consumption of a five-person household.

DAILY PRODUCTION PV AND COURSE OF THE SUN



SOLAR MODULES ON THE ENVIRONMENTAL CAMPUS

THIN-FILM SOLAR PANELS

Quantity	6,203
Effectiveness	9%
Nominal yield	75 Wp/module

MONOCRYSTALLINE MODULES

Quantity	246
Effectiveness	13.3%
Nominal yield	230 Wp/module

POLYCRYSTALLINE MODULES

Quantity	45
Effectiveness	12.3%
Nominal yield	235 Wp/module

Lighting System - Glowing Intelligence.



MAXIMUM ENERGY EFFICIENCY THROUGH USE OF DAYLIGHT

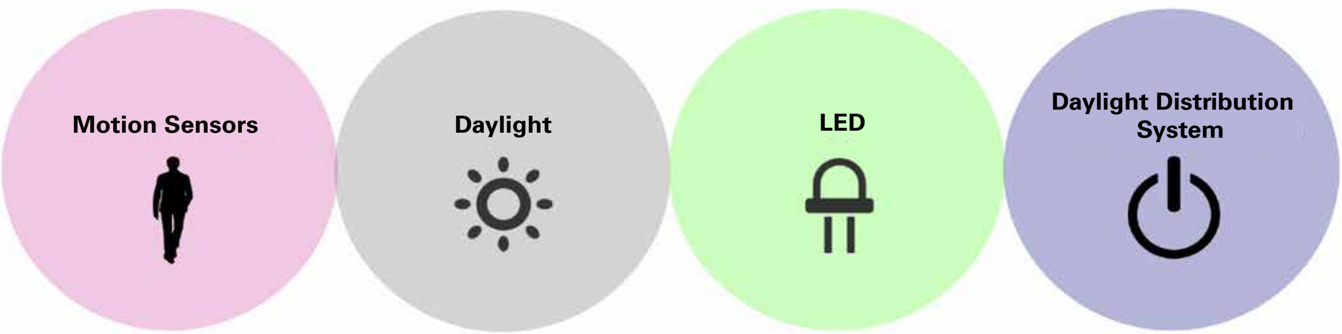
Various means are used to make sure natural daylight is exploited to the full at the Environmental Campus. Daylight is the most efficient source of energy, therefore it makes ecological and financial sense to use it in the best possible way.

In order to bring as much daylight as possible into the interior, large portions of the buildings are constructed of glass and built-in light shafts are also a feature. Slatted blinds are used to provide shade as necessary, thus reducing power consumption. These slatted blinds are installed both on the windows and on the roof of the central building. The position of the movable slats depends on the position of the sun, and they close automatically at sunlight levels in excess of 45,000 lux. Special safety features ensure the slats also close in frosty or windy conditions.

A so-called daylight distribution system is installed above the windows in the central building, consisting of glass tubes which convey the natural light into the interior and make it pleasantly bright inside the building. Insulation panels with glass surfaces on both sides redistribute the reflected light evenly throughout the rooms, which are thus filled with diffuse, non-glaring daylight. As a result, and also due to the good insulation properties of the panels, the period during the day when artificial lighting is required is reduced.

Both daylight and motion sensors regulate the artificial lighting in the individual rooms as required. The motion sensors make sure the light is only turned on when the room in question is actually used, thus helping to reduce electricity costs to a minimum. A further energy-saving measure is the use of energy-efficient LED light bulbs, e.g. for the entire external lighting system on the campus, in all the corridors and toilets. The toilet lights are switched off at 22.00h.

LIGHTING SYSTEM ON THE ENVIRONMENTAL CAMPUS:



Ventilation Technology - Air for Thought.

The ventilation plant does not only supply the lecture halls on the Environmental Campus with fresh air and thus comfortable room temperatures, it also includes sensors which regulate the CO_2concentration in the air.

These ventilation installations occupy a large portion of the technical centre located under the central building (Zentraler Neubau - ZN) and supply the following rooms:

- the aula (seating for 360 persons),
- the lecture halls in the ZN (seating for 100 - 140 per sons),
- the library,
- the seminar rooms (supplemented by the windows).

The technical centre also houses the following installations:

- an adsorption cooling plant for cooling purposes,
- a solar heat transmitter with heat storage capacity to provide heat,
- a distance heat transmitter supplied by a wood-fired power station,
- a geothermal heat transmitter to pre-warm the outside air,
- a solar thermal collector as heat source for a compres sion heat pump,
- two compression heat pumps,
- a rainwater cistern with a pressure regulator,
- two ventilation pumps fitted with high-performance waste-heat extractors.

The various technologies incorporated in the ventilation system are exclusively "zero emission", as they do not make use of primary energy from fossil fuel sources. Outside air is sucked in through three air intake towers which pass it on to two geothermal heat transmitters, each 55 m long and 1.50 m in diameter with a throughput capacity of 25,000 m³/h. In order to avoid damage to the ventilation machinery, the outside air has to be filtered after it has been sucked in. It is filtered a second time further along the process for air quality reasons.
The main source of ventilation in the aula is a heat transmitter with an efficiency rate of 80% combined with a multi-step, indirect condensation cooling system which uses rainwater to cool the air intake. Integrated into the multi-purpose waste-heat extraction system is a heat pump designed to utilize surplus heat in winter and to provide additional cooling in summer. This system uses directly operated, free-standing ventilators with an average capacity of 1.2 kW and a volume throughput of 9.800 m³/h. In order to ensure an optimum air exchange, the ventilators are controlled via CO_2 sensors and pressure gauges. This air is fed into the aula via four zones where it is then heated, cooled, or dehumidified by the individual room ventilation system as required. It was not considered necessary to provide for humidification.

The used air is extracted through a channel containing a number of interconnected plastic pipes filled with a glucose mixture. Any remaining energy can thus be captured by means of a compression heat pump which heats it up before redirecting it to the room ventilation system. The heat pump has a heating capacity of approx. 14 kW in winter and a cooling capacity of approx. 11 kW in summer; it has a connecting capacity of 4.5 kW. In order to allow the soil to regenerate, the surplus energy is redirected back into it. Every room on the campus is equipped with its own separate thermostat to regulate the room temperature.

Technical centre

Aula

Energy Efficiency - Intermittent Ventilation Technology.

In 2016 the new multifunctional gymnasium at the Environmental-Campus Birkenfeld is going into operation with an effective area of about 1.480 m². The installed intermittent ventilation technique is a valuable contribution to the enhancement of energy efficiency. The new ventilation technology has a favourable effect on the dimensioning of the energy supply of the whole hall, because electric and thermal energy can, as a result, be economized.

In the context of a research project (Backes, Kaup, 2016) the operating mode of an RLT-device for ventilation with 10.400 m³/h quantity of air has been optimised, by the use of an intermittent operating mode the needed air change could essentially be reduced. Ventilation efficiency is not only improved a lot at partial load, but also at full load; the volume flow rate overall is reduced by the factor 2.

Simultaneously there is just a slight risk of draught and the quality of air is significantly improved, this, additionally, enhances the feeling of ease and comfort, because the pollution load (e.g. CO_2) is reduced, since pollutants can be degraded at a faster pace. At the same time, the efficiency of air flow at full load can be advanced, especially with small air change data. Having an air volume of 12.580 m³ in the gymnasium, there is an air changing rate of 0,82 per hour at maximum volume.

Multifunctional Gymnasium at the Environmental-Campus Birkenfeld

Cooling System - Cooling with the Sun.

PLEASANT TEMPERATURES IN SUMMER AND IN WINTER.

Comfortable indoor temperatures in the buildings of the Environmental Campus are maintained by a central adsorption cooling unit which cools the air, floors and walls of the rooms via the circuit cooling system.

Located in the technical centre in the basement of the central building, the adsorption cooler has a maximum capacity of 175 kW and goes into operation when the average outside temperature reaches 19° C. The cold water it produces is fed into the circuit cooling system and used to cool the individual rooms as required.

In the first phase of the cooling process, the thermal energy from the solar energy installation and from the wood-fired power station play an important role. These heat sources supply the adsorption cooler with 100% CO_2-neutral heat. The solar energy installation covers an area of 200 m² on the rooftops of the Environmental Campus and supplies 20 - 30% of the heat required by the cooler, the remainder coming from distance heat sources. The heat is needed to transform the cooling agent from liquid to gas. In the next step, this heat is extracted from the gas and piped back into the heat storage unit.

COOLING WITH CO2-NEUTRAL HEAT

NO CHEMICAL SUBSTANCES

MAKING USE OF RAINWATER

The cooling process itself plays a key role in the system. It produces cold water in the temperature range of 5° - 12° C by means of evaporation through the addition of silica gel as adsorption agent, thus avoiding the need for chemical cooling agents.

A cooling tower is used to cool down the cooling unit. This cooling tower operates with rainwater supplied from cisterns with a capacity of 36 m³. This environment-friendly system does not only supply the cooling unit, it also provides approx. 12 - 15 m³ of rainwater for flushing the toilets.

Adsorption cooling machine at the Environmental Campus

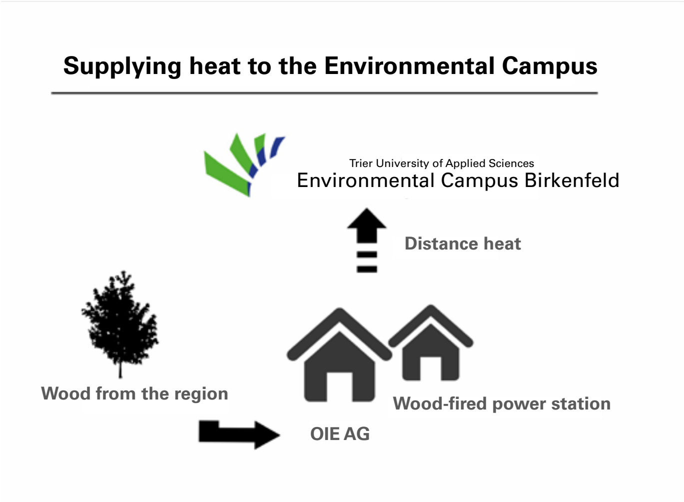
Heating System - Heat from Nearby.

Distance heat is supplied to the Environmental Campus by the OIE AG wood-fired power station in nearby Neubrücke. In 2014, the campus consumed 1.7 GWh of distance heat.

As the energy for the power station comes from wood, there is no need for fossil fuels such as oil or gas. Because of the high ratio of mature wood per inhabitant in Germany, which averages 100 kg per year or 8 mil. t/a, the fuel required by the power station - approx. 63.000 t/a - can be covered exclusively from existing stocks of old and residual wood. This means that wood does not have to be supplied from forestry or plantation trees, thus conserving resources. Furthermore, the old and residual wood stocks used come from regional sources, saving transport pollution. The OIE AG wood-fired power station obtains all its wood supplies from locations within a radius of 150 km of Neubrücke.

The old and residual wood, generally in the form of wood chips, is fired in the power station in order to release energy as steam which is subsequently used to generate electricity. A special feature of this power station is that 2 bar of steam is diverted from the main flow and fed into a distance heat network.

The substances occurring in the exhaust arising from the combustion process are subject to emission restrictions and limits which are strictly controlled. The wood-fired power station in Neubrücke is fitted with an integrated textile filter unit which separates solid particles. This filter mechanism is supplemented by a SNCR (selective non-catalytic reduction) process which uses ammonia to convert the nitrogen oxide in the combustion exhaust into elementary nitrogen and water.

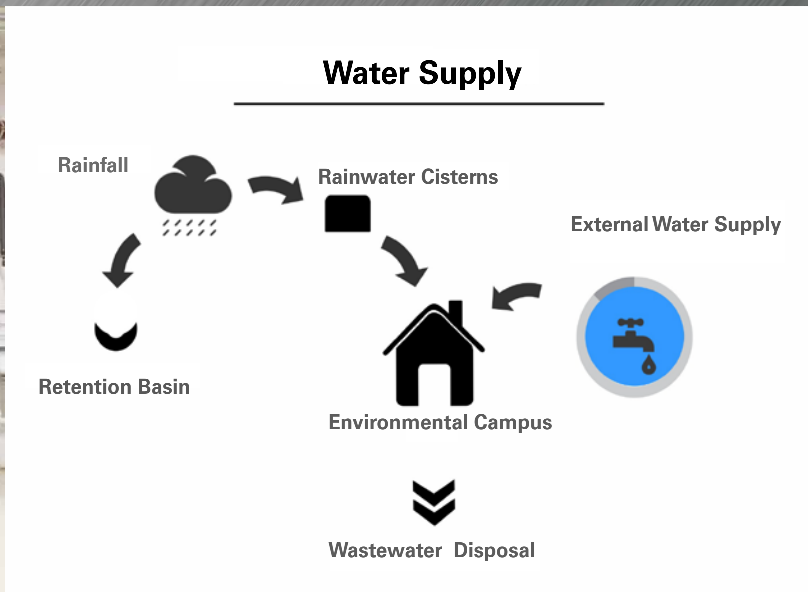


The fact that the Environmental Campus relies on distance heat from the neighbouring wood-fired power station in Neubrücke underscores its zero-emission concept. If the campus were to supply its own heating requirements from its own power station, this would necessarily make it dependent on fossil energy sources and thus contradict its commitment to protecting the environment.

As described above, the heating system of the Environmental Campus is based on the sustainable utilization of regional, non-fossil organic waste matter (wood chips) whose emissions are subject to continuous treatment processes and strict control.

Besides heating the Environmental Campus, the wood-fired power station also supplies heat to several neighbouring business enterprises, e.g. Fissler and Rofu.

Use of Rainwater - Collect. Store. Flush.



Control centre for the rainwater system

A rainwater collection and storage system on the Environmental Campus allows an annual saving of 800 - 1,000 m^3 of drinking water. As a total of 2,858 m^2 of water was consumed on the campus in 2014, this means that approx. one-third of the amount required can be covered by rainwater.

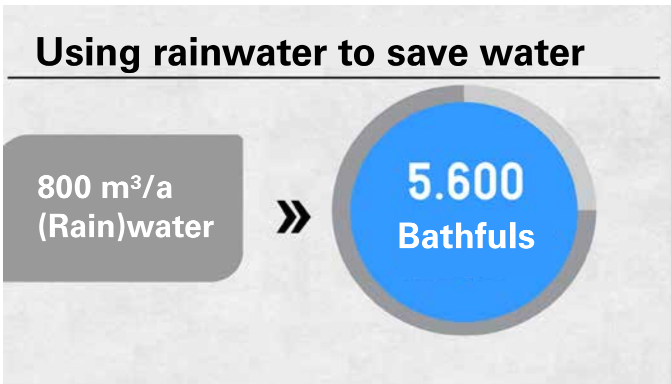
The roof surfaces of buildings 9916/17 and 9924/25, which together form an area of approx. 2,000 m^2, are used for collecting rainwater. It is then stored in two underground cisterns with a total capacity of 36 m^3 and filtered in preparation for further use.

If more rain falls than can be stored, the excess is simply piped into the local wastewater disposal system. The rainwater which falls on the roofs which are not used for rainwater collection is directed into retention basins at various points on the campus, where it either seeps into the soil or evaporates.

Most of the collected rainwater is used for flushing the toilets in buildings 9916/17/24/25/26/30 and in the central building. The remainder is conveyed to the water cycle of the adsorption cooling unit and used to water the planted areas outside.

Thanks to water-saving flushing options on the toilets, the collected rainwater generally suffices to cover normal needs. Apart from the 30% of urinals on the campus which operate completely without water, automatic taps also help to reduce the overall water consumption in the sanitary facilities.

Depending on the season and the weather, the rainwater stored in the cisterns is normally enough for at least two to three days. Should the demand exceed the supply, then tap water is used to supplement the rainwater.



The Communications Centre - a Look to the Future.

Opened on 28 June 2012, the communications centre is a further manifestation of the zero-emission concept of the Environmental Campus.

Technically speaking, the communications centre is a non-residential passive house with excellently insulated outside surfaces and highly efficient systems technology.

What makes this building special is the fact that it does not require a conventional central heating system fired with externally sourced energy. By definition, a passive house has such efficiently insulated walls and windows that comfortable temperatures are maintained inside - without the need for combustion emissions. The services technology installed in the building includes a ventilation system with integrated heat recovery and a lighting system based on motion sensors. A specially adapted control signals network ensures the ventilation system only runs when required, thus also helping to save electricity and prevent heat from escaping. The power needs of the building are supplied by the photovoltaic installation on the roof.

Inside, the communications centre houses a large multi-purpose hall as well as seminar and tutorial rooms, a tearoom, a gym and, fittingly, the Campus kindergarten - all in an enclosed passive-house environment on the Environmental Campus.

Communications centre at Birkenfeld Environmental Campus.

Authors and Acknowledgements.

Prof. Dr.-Ing. Susanne Hartard

Industrial Ecology
Telephone: +49 (0) 6782 17-1322
E-Mail: s.hartard@umwelt-campus.de

Prof. Dr. Henrik te Heesen

Technologies of Renewable Energies
Telephone: +49 (0) 6782 17-1908
E-Mail: h.teheesen@umwelt-campus.de

At this point, a special thank goes to Prof. Dr.-Ing. Susanne Hartard and Prof. Dr. Henrik te Heesen for the conception and the creation of this brochure. Based on an interdisciplinary student project they organized and constructed this technology brochure, which gives a comprehensive overview of the technologies installed at the Environmental-Campus.

Prof. Dr. Klaus Helling
Dean, Faculty of Environmental Business, Economics and Law

Prof. Dr.-Ing. Peter Gutheil
Dean, Faculty of Envionmental Planning/ Environmental Technology

Contact.

Hochschule Trier, Umwelt-Campus Birkenfeld

E-Mail: info@umwelt-campus.de
Internet: www.umwelt-campus.de

Telephone: +49 6782 17-18 19
Telefax: +49 6782 17-13 17

Make the environment your career! Take part!

Umwelt-Campus Birkenfeld
Hochschule Trier, Standort Birkenfeld
Postfach 13 80
55761 Birkenfeld
Telefon: +49 6782 17-18 19
Telefax: +49 6782 17-13 17
E-Mail: info@umwelt-campus.de

www.umwelt-campus.de