# Solvis Zero-Emission Factory
# – The ‘Solvis way’ – Structure and Subject

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**Abstract**

The philosophy of Solvis is simple: The optimal use of solar energy with mature technology and as little use of the environment as possible – for the good of everyone. The central pillar of the product range of this employee-run company is the SolvisMax solar boiler. It combines a solar stratified storage tank with a heating boiler in one unit, thus providing hot water and supporting heaters. To produce ecological products also in an environmentally-friendly building, Solvis moved 2002 into its zero-emissions plant. The concept and structure of this new plant are described within this keynote-paper.

**Keywords:**

Sustainable Building Concepts, Zero-Emission Factory

## 1 INTRODUCTION

To produce ecological products also in an environmentally-friendly building, Solvis moved 2002 into a zero-emissions plant (Figure 1). The Energy consumption was reduced by 80 percent over conventional in-dustrial plants. 100 percent of the supply of heat and power comes from regenerative energy, which is hence CO2-neutral. With a floor area of nearly 15,000 m², the building is the largest zero-emissions plant in Europe. The building has already received several awards, among them the European Solar Prize 2002 and the worldwide Energy Globe 2003 and also as the “the most energy-efficient commercial property” of Germany with the Energy Performance Certificate for buildings according to the German Energy Conservation Regulations 2007.

Figure 1: The Solvis zero-emission factory

## 2 THE 'SOLVIS WAY' - STRUCTURE AND SUBJECT

The administrative areas included in the production site at Grotrian Steinweg Strasse personify the situation of the building's main access and an enclosed 'atrium' as a high-quality external space within the building volume, that is otherwise optimised with regard to the A / V relationship.

The lengthways opening-up of the building is carried out as a central internal opening-up; internal movements of persons meet the product lines here.

The internal central way, as a themed lengthways axis of the building, became the central situation of the building, the 'backbone' of the overall system, acquired its conceptual, contextual significance as 'Solvis way'.

The constructional realisation of the Solvis way and connected administrative areas was carried out as a reinforced concrete construction, for reasons of thermal storage capacity, in the direction of the nocturnal cooling possibilities of the building masses, and for reasons of optional fire safety classification. On the ground floor, all the necessary ancillary rooms for the functions and sanitary installations are enclosed in the 'Solvis way' and the complete building technical installation can be seen on the first floor.

Figure 2: Solar collectors above the atrium

The Solvis way gives the building concept its specific identity, as a space for coordinated organised building technical installations, and is the identity-forming central area for Solvis, the manufacturer of building technical installations.

The production and storage areas were conceived as a wide-spanned lightweight wood construction over 27.50 m connected on both sides to the primary reinforced concrete construction of the Solvis way, taking the primary energy contents of the building materials.

The connections of the internal lengthways axes of the wooden construction to the massive construction enabled all horizontal loads from the wide-spanned roof construction to be absorbed.

The two external lengthways axes of the wide-spanned wood construction were implemented as column constructions with non-bearing wooden element facades, alternatively as high-temperature insulated wooden frame constructions.

J. Hesselbach and C. Herrmann (eds.), *Glocalized Solutions for Sustainability in Manufacturing: Proceedings of the 18th CIRP International Conference on Life Cycle Engineering, Technische Universität Braunschweig, Braunschweig, Germany, May 2nd - 4th, 2011*,
DOI 10.1007/978-3-642-19692-8_5, © Springer-Verlag Berlin Heidelberg 2011

## 3 ENERGY AND DAYLIGHT CONCEPT

The goals of the planning stage were high quality workplaces with the same standard with short communication paths and production without emissions of climatic gases.

Because of the production processes, emissions from the energy requirements for electricity and heat are the only potential sources of pollution, the conception of a zero-emissions factory is therefore above all an energy concept for reducing the electricity and heat requirement and a concept for a CO2-neutral energy supply.

Thanks to the external supporting framework of the wooden truss construction of the production areas with the 27.50 m span, the building volume that was to be heated and ventilated was reduced by 1.20 m headroom (15 % of the complete enclosed space). Loading zones for trucks connect to the production and storage areas. These zones were integrated into the thermal shell of the production areas. The solar energy plant is built on the loading zone that is oriented to the southwest. The supports for the hall's external supporting framework hold the thermal collectors.

The high-quality thermal protection and the compactness of the cubage of the overall project enable a heating requirement of < 30 kWh/m²/a.

The sun (PV, collectors) is available as the supplier of energy without $CO_2$-equivalent; as a regenerative supply of energy rapeseed oil is used as a supplementary source of electricity and heat, and a rapeseed oil fired block-type thermal power station is in use.

With energy supply from excess energy from a PV generator and the substitution of electricity from conventional generation, $CO_2$-neutral energy supplies can be achieved with internal electricity generation even with conventional rapeseed oil cultivation.

The target values for the heat with 40 kWh/m²/a and for the electricity consumption for the building's technical installations with 20 kWh/m²/a result from the tresholds of the federal economics ministry's subsidy concept for solar-optimised buildings. In addition, restrictions to 20 kWh/m²/a heat and 12.5 kWh/m²/a electricity for the building's technical installations and operations result from the objective of $CO_2$-neutral energy supplies and the maximum available space of 600 m² for the installation of PV modules and solar collectors. The target values demonstrate that, together with a very low heating requirement, in particular the electricity requirement for the building's technical installations should be very low. For this reason, the main focuses for improvements are on energy-efficient ventilation, a good supply of daylight and adapted lighting, and integration of the solar energy supply.

## 4 ROOM AIR CONDITIONS AND THERMAL INSULATION IN SUMMER

Thermal insulation in summer in the offices is guaranteed by an external two-part heat protection. A reduction of the g-value (total energy transmittance) is achieved by using triple heat protection glass. In addition, the opening parts of the windows are designed as wooden panels with vacuum insulation, so that a reduction of the heat yield in summer is achieved without increasing heat losses. These are reduced considerably by means of a consistent reduction in internal loads, e.g. by performance management in electronic data processing and by demand-oriented lighting controls.

Because of the dense layout, it is necessary to lose heat in summer through nighttime ventilation (change of air: 3/h). There is a mechanical ventilation system to make the building safe from break-ins. There are 245 working hours with temperatures in excess of 25°C; this is less than 9% of the working hours.

## 5 HEATING REQUIREMENT

A low heating requirement is achieved on the one hand by a good thermal installation standard and on the other hand by an efficient ventilation plant with heat recovery in the production areas. Precondition for achieving the heat supply level of >75% is a very airtight building shell. The building achieves a very low change of air volume of 0.22 1/h at 50 Pa partial vacuum/excess pressure. This value was verified by a blower door measurement.

A heat requirement of 220 MWh/a results for the building (determined by dynamic building simulation); this is 27 kWh/m²/a in relation to the net floor area with internal loads of 150 Wh/m²/d.

## 6 DAYLIGHT USE AND LIGHTING

The production halls receive an average daylight quotient of 3% through the fanlights, so that there is a supply of daylight adjusted to requirements. The lighting is dimmed automatically in dependence on the daylight by an external brightness controller; on the one hand this reduces the costs in comparison with a decentralized controller and, on the other, the dependence of the sensors on the reflection properties of the surfaces in the inside of the building is avoided.

The offices are well supplied with daylight (daylight quotient in the area of the workplaces average 4.5%, daylight autonomy: 77% in 0.75 m room depth, 47% in 2.75m room depth); as in the production halls the lights are grouped with a daylight-dependent controller and dimmer.

## 7 ELECTRICITY REQUIREMENT

Even now, a major part of the electricity (approx. 55%) is required for lighting and computers/communications. For this reason, in the main 'conventional' energy saving measures were carried out in the field of electricity supply. These include lighting controllers, TL5 fluorescent lights, flat screens, low-energy actuators for pumps and ventilators and energy-saving operations for the computer systems.

Thanks to a vacuum drainage system the water requirement is reduced by 80% in comparison with conventional drainage systems. The remaining wastewater is fed into the municipal sewer, because the clarified sludges are processed further in a block-type power station.

## 8 SOLAR ENERGY SUPPLY

The heating is supplied by a rapeseed oil factory heating and power station (180 MWh/a.), a collector plant (20 MWh/a.) and by the heat waste from the development department (20 MWh). The current demand is covered by a 60 kWh PV-plant (45 MWh/a.) and via the rapeseed oil factory heating and power station (115 MWh). Thus the energy supply is provided by regenerative energy sources. The primary energy demand for heating and current is 700 MWh/a., which equates to 90 kWh/m² p.a. The collector plant and the PV-Generator achieve a solar contribution of 22%. Additional expansion of the photo-voltaic current generation is limited from an economic point of view and also because of the lightweight construction of the hall.

The non-insulated sprinkler tanks set up in the building serve as a buffer store for the 150 m² thermal collector system and thus as low-temperature radiant heating system. The waste heat from the burners in the development area is fed via a busbar to the buffer store of the rapeseed oil factory heating and power station. In winter, the waste heat from the EDP central office serves as a heating support for the warehouse, in summer a circulation fan is used here.

Figure 3: Solar collectors on top of the Solvis plant

## 9 BUILDING EXTENSION

By firm growth a building extension became necessary of 5.400 m². The new building part is used completely as central storage depot. By four lowerable stages it is possible to load at ground level up to 30 trucks daily. With a new automated production line, in which the smaller compact collectors are manufactured, Solvis is in the position to produce altogether annually up to 300,000 m² collector areas. Three laser welding machines make a capacity with absorber production of up to 500,000 m² possible. Additionally further offices and a training area on approx. 1,000 m² extended. For the measures the photovoltaic-plant was supplemented around 2.000 m², a thermal long term storage with 100.000 litres of volume supports the heat supply. With these additional activities Solvis invested 10 million Euros.

## 10 CONCLUSION

The target values for heating consumption of 40 kWh/m²/a. and a current consumption of 20 kWh/m² p.a. for the building facilities are considerably undercut, the primary energy consumption being 90 kWh/m²/a. The excellent thermal insulation as well as the consistent planning and implementation of low-energy building facilities means that the new production building of the company Solvis can be completely supplied using regenerative energy sources and in the future will become a zero-emission factory with $CO_2$-neutral rapeseed oil production. Through the minimisation of its regenerative energy resource requirements, the Solvis zero-emission factory has also become a model of how buildings could be supplied with energy within industrial and commercial construction in the future.