

# *SolarBau* – ENERGY EFFICIENCY AND SOLAR ENERGY USE IN THE COMMERCIAL BUILDING SECTOR

A German demonstration program for the non residential building sector

## **INTRODUCTION**

The following report presents the description and initial evaluation of the German RD&D program for solar optimised buildings, the so called 'SolarBau Program', which was initiated by the Federal Ministry of Education and Research (BMBF) in 1995 and since 1998 carried out by the Federal Ministry of Economy and Technology (BMWt). Consisting of a number of demonstration projects, spread over all regions of Germany, the program's objective is to demonstrate the feasibility of highly energy-efficient buildings for non residential purposes with special regard to solar optimisation. The technical concepts for all buildings are based on an integrated approach considering heat and electricity consumption. Started in the year 1995, the program was planned to cover a period of 10 years with a budget of approx. 5 MEURO/a.

## **OBJECTIVES OF THE PROGRAM**

The sector of non residential buildings was selected with special regard to the large potential for saving energy and the promising dissemination effect, resulting for instance from the increasing importance of the trade and the services sector in Germany. Considering the present situation in Germany, 16% of the final energy consumption is caused by small scale commercial consumers. Trends, as recently published by PROGNOSES 99<sup>1</sup> and considering the whole sector until 2020 are predicting a slight decrease related to 1995. However more sophisticated analyses show different tendencies, depending on the type of consumer. For instance for the expanding service industry sector and to a less extent the trade industry an increasing energy demand of 19% and 8% are expected. Energy savings due to reduced heat consumption are going to be partly compensated for by increasing demand for electricity.

Being part of the 4<sup>th</sup> German Energy Research and Development Program, SolarBau is one of the major activities in the framework of rational use of energy. Addressing particularly the typical properties of commercial buildings, the program is striving to take up existing energy saving opportunities. Its main object is to develop and prepare technical and scientific

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<sup>1</sup> PROGNOSES 99: Die längerfristige Entwicklung der Energiemärkte im Zeichen von Wettbewerb und Umwelt, Basel, 1999

background information for future legal measures such as the German energy saving ordinance, which should limit energy consumption in the building sector.

SolarBau's general objective is to demonstrate a series of pilot projects with a total primary energy demand for heating, cooling and lighting purposes below 100 kWh/(m<sup>2</sup>a) including a space heating demand of less than 40 kWh/(m<sup>2</sup>a). This target will be achieved by integrated concepts based on the interplay between solar passive and active approaches, advanced HVAC techniques and innovative thermal insulation measures. The program consists of various parts, comprising the development of components and planning tools, the demonstration of up to 25 pilot buildings and an accompanying evaluation and information program called SolarBau: MONITOR.

Besides the advanced technical targets, economic aspects will be an important consideration for the SolarBau projects. In this context it is anticipated that additional expenses for the integrated design process should as far as possible be compensated for by lower investments for the HVAC-installations and reduced maintenance costs.

## **PROCESS OF DEFINITION/DESIGN OF THE PROGRAM**

SolarBau's concept is based on a sophisticated analysis of specifications and requirements to be met by non residential buildings and determining their heat and electricity consumption. An experts group was set up to develop and design SolarBau's basic concept in close co-operation with the responsible ministries. The group consisted of five representatives from:

- university research
- private research
- architects and engineers
- ministry and project management organisation

## **MAIN ACTORS AND THEIR ROLES**

As in the conception phase, the main actors playing a role in the SolarBau program come from various branches of research, industry and public bodies. The responsibilities are allocated as illustrated in Tab. 1. Although competence and experience of a participant in the field of energy saving engineering is important, it is not the only criteria for participation. Additionally the readiness to contribute to the accompanying SolarBau: MONITOR program, which is based on a high degree of co-operation during all project phases, is being pre-condition to participate.

<b>Main actors and their roles in the SolarBau Program</b>	
Federal Ministries (BMBF, BMWi) Project Management Organisation (BEO)	funding and co-ordination
universities Fraunhofer Gesellschaft private institute	<ul style="list-style-type: none"> <li>- theoretical background</li> <li>- development</li> <li>- monitoring and evaluation</li> </ul>
industry	<ul style="list-style-type: none"> <li>- development of new materials and systems</li> <li>- production of innovative components</li> <li>- market introduction</li> </ul>
architects and engineers	<ul style="list-style-type: none"> <li>- construction of demonstration buildings</li> <li>- monitoring and validation</li> </ul>
<u>SolarBau: MONITOR</u>  researchers and developers  architects and engineers	<ul style="list-style-type: none"> <li>- communication</li> <li>- documentation</li> <li>- analysis</li> <li>- training</li> </ul>

*Tab. 1 Main actors and their roles in the SolarBau program*

### **POLICY MECHANISMS USED**

As already mentioned, SolarBau is part of the 4<sup>th</sup> governmental funding program for energy research and development, therefore the R&D activities are supported according to usual funding conditions. In the demonstration part, funding is only provided for the design of prototype buildings and for monitoring activities after construction. Complementary development activities, aiming at the production of new innovative components are also supported according to R&D framework conditions. Since no subsidies are provided for investments, it is ensured that all design solutions are realised under normal economic boundary conditions.

## MONITORING AND EVALUATION PROCESS

The monitoring, evaluation and documentation in SolarBau is being carried out by independent institutes and companies. An internet platform at [www.solarbau.de](http://www.solarbau.de) (German) provides information for participants as well as for the general public. Project reports are being produced regularly and workshops are being held to provide information on the experience gained.

Special emphasis in the area of evaluation has been given to the generation of a neutral basis, allowing the comparison of energetic properties of the monitored objects. Up to now, in the framework of SolarBau eleven non-residential buildings are under construction or have been already erected. Tab. 2 gives an overview on the building types, net floor areas and status of completion and Tab. 3 contains a description of applied measures and components<sup>2</sup>.

Project name	Location	Building type	Net floor area	Status
ECOTEC	Bremen	office	3436 m <sup>2</sup>	finished
Passivhaus Wagner	Coelbe / Marburg	office	1948 m <sup>2</sup>	monitoring
Hübner	Kassel	production	2122 m <sup>2</sup>	monitoring
Fraunhofer-Institut für Solare Energiesysteme FhG	Freiburg	research institute	14001 m <sup>2</sup>	under construction
DB Netz	Hamm	office	5974 m <sup>2</sup>	monitoring
Fachhochschule Bonn-Rhein-Sieg	St. Augustin	university	26987 m <sup>2</sup>	monitoring
Gesellschaft für Innovation und Transfer GIT	Siegen	offices and laboratories	3300 m <sup>2</sup>	planning
Passivhaus Lamparter	Weilheim	office	1488 m <sup>2</sup>	monitoring
Technische Universität Braunschweig	Braunschweig	computer centre	9415 m <sup>2</sup>	under construction
SurTec	Zwingenberg	production and office	4423 m <sup>2</sup>	under construction
Zentrum für umweltgerechtes Bauen ZUB	Kassel	training and research	1108 m <sup>2</sup>	under construction

*Tab. 2 Demonstration projects, status May 2000*

According to the focus on office buildings the implied strategies are mostly based on passive cooling and advanced daylighting measures. Both are being addressed in the IEA Implementing Agreements 'Energy Conservation in Buildings and Community Systems' and 'Solar Heating and Cooling'.

<sup>2</sup> Voss, K. (FhG-ISE), Löhnert, G. (solidar) and Wagner, A. (Uni Karlsruhe): 'Towards lean Buildings – Examples and Experience from a German Demonstration Program for Energy Efficiency and Solar Energy Use in Commercial Buildings'

Methods	Titel	ECOTECC	Wagner	Hübner	FhG-ISE	DB AG	FH-BRS	GIT	Lamparter	TU-B	SurTec	ZUB
		Integrated planning		+	+	+	+		+	+	+	+
	Simulations	(+)	+	+	+	+	(+)	+	+	+		+
Strategies	Reduction of space heating demand	+	+	+	+	+	+	+	+	+	+	+
	Passive cooling		+	+	+	+	+	+	+	+	+	+
	Daylighting		+	+	+	+	+	+	+	+		+
	Renewable energy use	+	+	+	+		+		+			
Technologies and measures	Atria				+	+	+			+	+	+
	Transparent insulation						+					
	Solar thermal	+	+	+	+				+			
	Solar electricity	+			+		+		+			
	Heat recovery	+	+	+	+	+	+	+	+		+	+
	Nocturnal ventilation		+	+	+	+	+	+	+	+	+	+
	Slab cooling											+
	Ground heat exchanger		+	+	+	+	+	+	+	+	+	+
	Combined heat & power		+		+		+					
	Combined heat + power + cooling				+							
	Heat pump	+						+				
	Biomass											
	Advanced controls	+	+		+	+	+	+	+			
	Rain water treatment		+	+					+		+	
	“Ecological materials”			+			+		+			+

Tab. 3 Technologies and Strategies

The comparison of investment costs, as indicated in Fig. 1, shows that SolarBau buildings are within the range of the German reference costs for office buildings of medium to high standard as published by the 'Construction Costs Information Centre' of the 'German Chamber of Architects (BKI)', based on mean building costs per m<sup>2</sup> usable floor area for given building types in Germany. The results so far from the SolarBau projects demonstrate that special features of advanced energy saving concepts do not necessarily have to result in increased building costs.

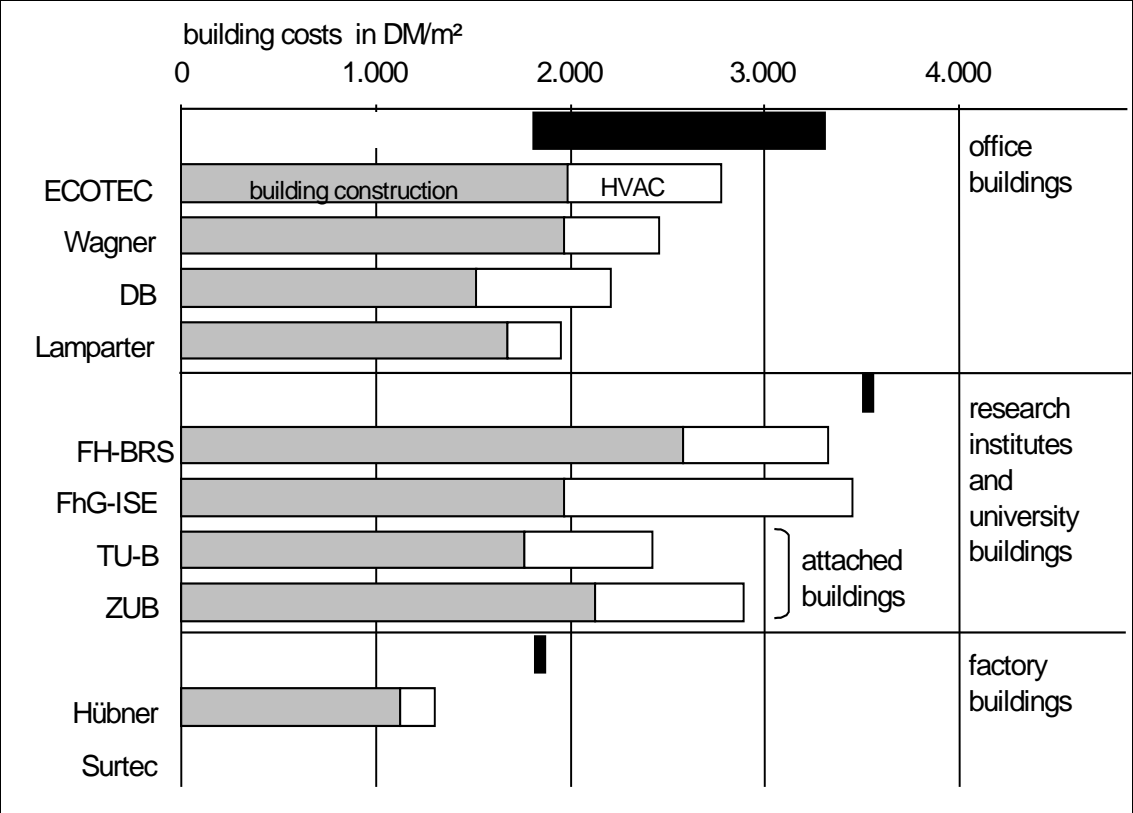


Fig. 1 Investment costs incl. tax per net floor area for construction and HVAC system, excluding planning and site costs. Black bar: Range of reference costs for conventional building practice, Germany (BKI99), Ref.:<sup>2</sup>

**DISCUSSION OF THE RESULTS**

With regard to energy consumption, data acquisition started recently. First results show that the anticipated limits can be met without significant additional costs. However the program has not yet been finished and an advanced standard for energy consumption in commercial buildings is going to be established. The positive public response, which has led to first emulations, confirms the program's objectives. As a consequence, in future projects it will not

be necessary to fund the construction phases in the same way because the standards and methods of SolarBau are well accepted.

The present results, half-way through SolarBau's project period, exceed expectations by far and promise significantly reduced energy consumption of commercial buildings down to about one fifth of the present average value. However, it does not suffice to know how to construct such buildings. They have to be built, critically compared with conventional buildings, well-documented, the experiences made-use of in planning and building practices and, last but not least, disseminated in training and further-education programs for planners and architects.

*Forschungszentrum Jülich GmbH  
Projektträger BEO  
Dr. Sabine Semke  
52425 Jülich  
Germany*