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und Raumordnung

FORSCHUNGSINITIATIVE  
**ZukunftBAU**



# Building the Future

The magazine of the Zukunft Bau research initiative



Government building as a role model | The future of building research | surPLUShome | Solar Decathlon 2010 | Energy – environment – emotion | Building the SOLON headquarters in Berlin-Adlershof | How solar is the future of building, Mr Ruth? | Demolition or redevelopment | 'The Old Village School Multiple House' | A future for empty spaces? Interview with architect Jana Reichenbach-Behnisch | fertighauscity5+ | ImmoWert | Forward-looking and sustainable industrial buildings | Indoor navigation systems | Graduated building components | Predictive operating procedures | The construction materials market of the future: interview with Tanja Brockmann D.Eng. | Ensuring the future-capability of buildings and building complexes | LED lighting | Innovations in the building industry

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# Strengthening the spirit of innovation and application expertise



Foto: BMVBS

With its enormous gross value creation and millions of employees, the buildings and real estate sector – which is dominated by small to medium-sized companies – is undoubtedly one of the biggest and most important industries in Germany. Its economic and ecological potential is considerable. We would like to strengthen its potential in these areas. The better we can maintain and expand the industry's economic strength and power to deliver, the better we will succeed in this aim. Crucial in this connection is the ongoing improvement of building quality. The key to this, in turn, is innovation. Innovations put us in a position to meet challenges successfully – both in connection with climate protection and with social requirements such as may arise from demographic changes, for example.

On the path towards the widespread use of the most up-to-date technology in the building industry, the applied building research of the Federal Ministry of Transport, Building and Urban Development is a decisively important component. With a view to ensuring rapid results, we are planning to extend this area of research activity more markedly in future. The objectives of the Zukunft Bau research initiative involve the joint investigation of complex themes and research topics in a cross-disciplinary network of scientific institutions and the building industry.

Just in the area of subsidised research in which the construction industry is involved, 165 projects have received support in the last four years. Many of the very practical results are already finding interest and acknowledgement worldwide. I would like to point in particular to the Plus Energy Houses of the Technical University of Darmstadt, developed under the auspices of the research initiative, which won the pres-










tigious Solar Decathlon competition in Washington in 2007 and again in 2009. This fantastic achievement underlines Germany's leading position as a provider of technology for the future in the construction industry, and opens up a wealth of new application possibilities. The Plus Energy House as a fuelling station for electrical vehicles is one of these – a possibility that we will now be examining in thorough practical tests. At the same time further research efforts will be allotting a central role to various sustainability criteria – e.g. making houses that can be completely recycled at the end of their useful life. We are also going to be concentrating on possibilities of modified use and maximum flexibility – while at the same time maintaining the highest standards of domestic comfort. To sum up, our Zukunft Bau research initiative should create a basis for meeting the highest expectations in terms of the future capability of buildings.

I wish all researchers, developers and users creative inspiration for coming up with new applications that prove valuable in practice.

A handwritten signature in black ink, appearing to read 'Peter Ramsauer', written in a cursive style.

Dr. Peter Ramsauer  
Federal Minister of Transport, Building  
and Urban Development

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The new Foreign Office building – the architects were Thomas Müller and Ivan Reimann  
Photo: Bundesamt für Bauwesen und Raumordnung [Federal Office for Building and Regional Planning]

## Federal building as a role model

### Innovative and sustainable building in federal construction projects



As a public developer, the federal government is the most exposed representative of German building culture. Its buildings are the focal point of discussions about sustainable and energy-efficient building. In this connection it both has the task of providing adequate quality standards and at the same time putting them into practice in exemplary style. The starting point for the efforts of the Federal Ministry of Transport, Building and Urban Development to provide top-quality sustainable buildings is the national sustainability strategy followed by the federal government. This defines targets and indicators and is a yardstick for departmental policies. The current coalition agreement of the federal government specifies that this sustainability strategy should be further developed in an established institutional framework. The coalition agreement further states that the federal government should continue to live up to its function as a role model for building culture and sustainability in future building projects. The results of research and development – including those of the Zukunft Bau research initiative – will be comprehensively and promptly put into practice by the federal government.

**Ministerial Director Günther Hoffmann**

Federal Ministry of Transport, Building and Urban Development

Head of the Building, Construction Industry and Federal Buildings division

With its current building policy, the federal government is able to build on an excellent base of sustainable and energy-efficient buildings. Already at the time of the move of the constitutional organs of state and the highest federal offices from Bonn to Berlin the federal government, implementing a resolution voted by all parties in the German parliament, set an exemplary lead in improving the energy efficiency of government buildings in Berlin or rebuilding them altogether. Among the goals envisaged, a figure at least 40% below the then requirements of the Thermal Insulation Directive was aimed at, and around 15% of the energy supplied was to come from renewable sources.

With the development of an energy solution for each building – a solution which was then consistently put into practice under the inspection of an energy officer of the federal government – it proved possible to attain to these targets and in some cases even to exceed them.

In drawing up an energy balance for the constitutional organs and all the highest federal government offices in Bonn and Berlin, it emerged that the buildings scored between 20% and 60% better than required by the Energy Saving Directive of 2007. The specific transmission heat losses were up to 75% lower than the required level. Such results are made possible through the implementation of the highest construction heat insulation standards and the use of energy-efficient ecological supply systems, so as to limit the use of primary energy to cover the energy requirements of the building. In the Spreebogen a particularly innovative power supply solution was developed for the parliament and government buildings.

Key features here were the use of:

- Cogeneration plants
- Seasonal reservoirs (aquifers)
- DEC/Desiccant Cooling Systems for treatment of room air
- Photovoltaic systems

In addition, the power supply to the buildings of the German parliament is linked to a subterranean energy network. This power supply solution manages to achieve a regenerative coverage rate of 60%, as demonstrated by monitoring while the buildings are in use.

In the course of the relocation of the government, 10,000 sq m of photovoltaic systems with an output amounting to 825 kW (peak) and 1,500 sq m of solar thermal systems were set up on or around the parliament and government buildings in Berlin.

In addition, the following innovative systems amongst others were used:

- Systems for solar refrigeration (absorption or adsorption refrigerating machines in combination with solar thermics)<sup>1</sup>
- Cogeneration plants running on plant oil
- Geothermal exchangers for the pre-heating or pre-cooling of atmospheric air for ventilation systems

Monitoring of the yield of the photovoltaic systems of the parliament and government buildings in Berlin shows that they are now supplying something like 500 MWh of electrical power annually.

The experience derived from the government buildings in Bonn and Berlin was consistently used as a basis for further developments in the BMVBS Leitfaden Nachhaltiges Bauen [Guidelines for Sustainable Building]. The use of systems for the use of regenerative energy in government building projects has now been made an integral component of the Guidelines. One of these prescribes, for example, that from a certain building volume upward a part of the funding shall be dedicated to measures for the use of regenerative energy. The Guidelines were published as long ago as 2001, and have been made mandatory for all government building projects. Many government buildings, like the new offices of the Umweltbundesamt [Federal Environment Agency] in Dessau, are illustrations of the role model function of the federal government in this field.

<sup>1</sup> DEC systems are thermal refrigerating machines for room ventilation, similar to absorption and adsorption refrigerating machines. Unlike the latter, however, DEC systems are open systems which generate conditioned air directly by a combination of evaporation cooling and depletion of atmospheric humidity. (Source: www.bau-netzwissen.de)



The Federal Environment Agency in Dessau-Rosslau  
Photo: Annette Kisting and Busse (Ministry for Regional Development and Transport of the State of Sachsen-Anhalt)

The new offices of UBA [the Federal Environmental Agency] were completed in 2005. The building has a gross floor area of 40,000 sq m and can accommodate 780 employees. The use of energy-efficient components in the building shell resulted in a structure on the borderline between a low energy house and a passive house. The building has an annual primary energy requirement of 73 kWh per sq m per annum and falls almost 50% below the current Energy Saving Ordinance limits. The total energy use registered comes to an average of 86 kWh per sq m per annum. The annual power requirement in the planning phase amounted to 35 kWh per sq m (gross surface area) per annum.

Important features leading to this result were the following:

- Use of daylight
- Energy-saving lighting fixtures
- Daylight-dependent and/or presence-dependent lighting controls
- Use of energy-efficient working resources
- Ventilator-supported air conditioning with minimum loss of pressure
- Cooling largely supplied by adsorption refrigerating machines.

The complicated decision-making process required for the sustainable building of UBA Dessau can be illustrated in the planning of the external façade. This was based on the compilation of a catalogue of specifications dealing with energy-saving, lifecycle costs and ecological aspects in accordance with the 'Leitfaden Nachhaltiges Bauen' ['Guidelines for Sustainable Building']. The system of wooden façades that was eventually realised was the result of extensive preliminary studies, taking ecological, economic and architectural considerations into account and involving controversial discussion

about the weighting of the different sustainability indicators. Last but not least, the design was consistently in keeping with the competition specifications and so with the explicit socio-cultural aims of the user. UBA Dessau has been subsequently certified for sustainability: with a rating of around 89%, it meets the Gold standard and is still today one of the most sustainable buildings in Germany.

The government's present building activities are dominated by the implementation of the current European Energy Performance of Buildings Directive (2010/31/EU). This requires all new buildings constructed in the European Union from 2021 to be nearly zero-energy buildings. Public buildings must meet this standard by 2019. Admittedly the specifications for the 'nearly zero-energy' standard still have to be defined at national level. But it is already certain today that buildings constructed in future must have much lower energy consumption, and their minimal energy needs will for the most part be covered by renewable energy. At the same time the government is working to realise the standards laid down in the new BMVBS Guidelines on Sustainable Building.

In a first pilot project, these requirements are being comprehensively implemented in a **UBA building in Berlin**. The building will have around 1000 sq m (net surface area) and will accommodate some 35 members of staff. The budget for the project has been set at around three million euros. The building has been designed as a zero energy house. The project group responsible agreed on the objective of covering the entire energy requirements (annual balance) of the building through the use of renewable energy, and on this basis taking into consideration not just the energy required for





Federal Environmental Agency building in Berlin, Bismarckplatz; Photo: Andreas Meichsner/Bundesamt für Bauwesen und Raumordnung [Federal Office for Building and Regional Planning]

the building utilities (heating, hot water, ventilation, lighting and cooling systems) but also user-specific energy consumption in its entirety (PCs, monitors, printers, lifts, kitchen equipment etc.).

The ultimate target was to design and build a 'net zero energy house'. To limit energy consumption, the passive house standard was taken as a starting point. The technical solution to be developed with a view to covering the remaining energy requirements is also being assessed on the basis of sustainability considerations. In this connection a lifecycle analysis is being carried out. This takes into account the costs of implementation and the associated use of resources.

380 PV modules are being installed on the roof, with an output of around 58 kW (peak). The layout of the modules was optimised with a view to maximising the annual power output generated. The system will have an annual power yield of around 48,000 kWh, which is sufficient to cover the building's power supply completely. In the present state of planning the net produc-

tion costs for cost groups 300 (Architectural Engineering) and 400 (Technical Building Equipment) come to around € 1850 per sq m (gross surface area). This makes them around 25% more than comparable average costs. Even taking into account the fact that UBA Berlin aims for a higher standard than that set by the EU Directive, there is still some development potential to be exploited for the building and perhaps in connection with comparable future projects.

These examples give an impressive demonstration, in my view, of the way in which the federal government is continuing today, as in the past, to support developments in the building industry with innovative initiatives and signally succeeding in implementing the latest results of development and research. Through the consistent application of the most modern technologies and materials, the federal government will still be in a position in future to create sustainable and energy-efficient buildings, and so maintain exemplary standards of building in Germany. ■

# The future of building research

## Interview with Ministerial Secretary Hans-Dieter Hegner

**Hans-Dieter Hegner Dipl.-Ing. is Ministerial Secretary and Head of Department B 13 (Construction Engineering, Sustainable Building, Building Research) at the Federal Ministry of Transport, Building and Urban Development (BMVBS). Mr Hegner directs and coordinates the Zukunft Bau research initiative.**

### **What has been achieved through the encouragement of building research?**

The Zukunft Bau research initiative of the Federal Ministry of Transport, Building and Urban Development is a programme of applied building research which is designed to enable small to medium-sized companies in the construction industry, as well as architects and planners, to overcome organisational hindrances in the construction field and to obtain a strong competitive position on the European internal market and beyond. Here the important thing is that the building trade should be able to make practical use of ideas resulting from research into fundamentals, as well as methods, materials and advanced technology current in the industry. Construction is essentially different from all known industrial processes. Buildings and building complexes are and remain unique systems. So that they may be able to respond to the challenges posed by society, we need to have not just methods and materials but rules, working aids, computing tools, organisation and holistic concepts.

In order to meet these targets, the Zukunft Bau

research initiative consists of two departments: Departmental Research (Ressortforschung) and Subsidised Research (Antragsforschung). Departmental Research focuses on the progressive elaboration of regulations in the construction industry (ranging from energy standards to certification and the HOAI fee regulation system). Subsidised Research on the other hand is largely a joint initiative between the construction industry, planners, academics and public authorities with the aim of developing new methods, materials and concepts for building. From 2006 to 2009 subsidised research was responsible for a total of 156 projects and commissioned research (Auftragsforschung) for 135. In the current year 2010 it looks as if 45 projects will have been carried out in each area.

### **What are the most important themes for the future of building? What does the building trade need to be concerned with?**

In my view, there are plainly three megatrends in social development. First of all, energy efficiency and the use of renewable sources of energy. The world's energy needs are increasing massively. The new global economic powers, like China, India and Brazil, need dramatic quantities of energy for their development, and so are successively becoming major culprits in the emission of greenhouse gases. With better energy efficiency and a higher proportion of renewable energy, we can ensure a more reliable energy supply for Germany while at the same time exporting German technology. The second megatrend, as I see it, is the efficient use of raw materials. Not only are rare earth elements becoming scarcer and dearer, there is also increased demand for classic construction materials like the metals. The increasing use of domestic raw materials is the indicated course, backed up by the organisation of infrastructure to improve the recycling capability of our buildings. As things are today, there is no alternative to an effective recycling-based economy. The building industry, which consumes around 50% of all raw materials and produces around 60% of all waste, is the most important partner



Ministerial Secretary Hans-Dieter Hegner  
Photo: Bauhaus, University of Weimar

in this process. The third major megatrend is demographic change in our country. Today we have 23% of the population aged over 60. By the year 2020 it will be over 30%, and still going up. Building activities and the modernisation of buildings must take this trend into account. Removal or reduction of restrictions on the construction and rehabilitation of buildings, guaranteed flexibility and reutilisation, backed up by government aid schemes, are the items on today's agenda.

#### **What measures are needed, in the Ministry's view, to encourage innovation in building?**

To strengthen innovation, we need to see a higher measure of commitment from the construction industry. The construction industry is a giant when it comes to turnover, but in terms of research it is puny. With a percentage that doesn't even amount to 0.1% of research expenditure against turnover as a whole, the industry is most probably right at the tail end of the economic rankings. This is to be put down to the extreme splintering of the construction industry, but in the long term things cannot be allowed to continue in this way. Not only is more investment needed on the part of the industry, we also need above all to see an amalgamation of the very splintered structures and interests that are involved. The increasing convergence of universities and academic institutions with industrial practice will lead to a more practical approach and the more rapid implementation of new ideas in building processes. The networks of politics, industry and science must be strengthened.

So there is altogether a great potential for innovation in the German building industry. On the one hand the industry has a certain reputation throughout the country for being unwieldy. On the other, we have to take into account the entire value creation chain in the building sector. Above all in the building product and supplier industries there have been considerable innovations achieved. In comparison with other European countries, the German construction industry is well up there at the top when it comes to

registered patents.

#### **What is the importance of the building industry for climate protection?**

Around 40% of Germany's entire primary energy budget goes on the running of buildings. At the same time we must be aware that 55% of all investments fall in the buildings sector. In the entire value creation chain the construction industry makes an 11% contribution to production in Germany and includes under its umbrella 12% of all workers liable for social security payments. In terms of investment in Germany overall, and based on its share in value creation, the construction, residential building and real estate industry is one of the biggest sectors of the national economy. This is where crucial issues like climate protection and energy efficiency are decided. So the key question is – how can investors and broad sectors of the population be induced to pay more attention to energy efficiency and sustainability aspects as a basis for their decisions?

The construction and real estate industry must submit offers along these lines. In terms of the national economy, the industry is the decisive partner for the attainment of energy and climate protection targets. So the construction industry actually carries a high measure of responsibility. It must find a mean between high energy efficiency targets, the economic considerations of investors and their sociocultural and functional expectations. This is a complicated and multifaceted task. To improve performance in this area in future, the federal government aims to promote the introduction and establishment of sustainability evaluation systems on the market. Here the government will set a good example with its own real estate management. An important point in this connection is to consider the balance of energy and raw materials, as well as the financial implications in relation to the entire lifecycle. Only in this way can we effectively shape the future.

**Energy-efficient building has met with little**

**acceptance from some planners and users. Why do you believe in the future of the plus energy house?**

Let's get one thing straight – the dramatically rising demand for fossil fuels like oil and gas absolutely compels us to a response. If our standard of living is not to be put at risk, we have to act. To me it appears obvious that this is not just a matter of energy consumption and reducing energy consumption, what we need is better energy management.

If a resource like energy becomes dearer, we just have to manage it better. For this we need multi-dimensional strategies. The plus energy house is an attempt at intelligent energy management, based on maximising the energy efficiency of the building shell, the technological infrastructure and domestic consumption, together with energy obtained from renewable resources and also the strategic use of accumulated energy surpluses. Energy surpluses may benefit not only mobility, but also perhaps historic and listed buildings which cannot be upgraded to zero energy standards. As I see it, the plus energy house is an important piece in a large jigsaw puzzle.

**Modern expectations of comfort are making houses into machines – with walls and ceilings that can provide heating and cooling, react adaptively to the environment and even produce energy. If houses are turning into power plants, do they remain architectural structures or are they being degraded to carrying systems for solar energy?**

Living, working and learning are modes of use with high functional, cultural and social expectations. When these expectations are not sufficiently met, we fall short of the goal of modern building. For that reason it is a prominent task of the Zukunft Bau research initiative to engage with this very issue.

One of the main areas of interest, for example,

is the intelligent use of façades to obtain energy while at the same time meeting high architectural standards. I would also like to point to themes connecting with thermally activated building components. Of course these must also take into account aesthetic and acoustic implications. So we will continue to live in houses that reflect our human scale, but they will be structured in multifunctional terms very much more than has been the case in the past.

**What kind of house do you live in? Is it all you could wish for?**

I live in a semidetached house that was built in 1994. I designed the house myself. It still meets the strict requirements of the most recent energy saving directive. I can draw up its energy balance and feel good about it. I added a solar thermal system a few years ago. The house is located in a recently developed residential area, but I only have to go a hundred metres to get to the nearest tram stop. It fits in well with my wanting to live as pleasantly and efficiently as possible in an urban setting. Though I do have ideas of improving the situation still further, e.g. with the help of photovoltaic modules and electrical vehicles. ■





The plus energy house of the BMVBS on its tour of Germany, here seen in Frankfurt am Main  
Further information:  
<http://www.bmvbs.de/SharedDocs/DE/Artikel/B/plus-energie-haus-bauen-fuer-die-zukunft.html>  
Photo: BMVBS, Leon Schmidt



# surPLUShome

Development, construction and competitive operation of an energy-saving prototype for future-oriented living in the year 2015 under the auspices of Solar Decathlon 2009 (surPLUShome)



**Team Germany of the Technical University of Darmstadt won the Solar Decathlon 2007 for the first time. In 2009 it had to defend its title. Solar Decathlon is an international competition for universities organised by the American energy department, and held for the fourth time in 2009. The teams of the twenty universities taking part have the assignment of planning and constructing a domestic house run solely with solar energy and carrying out competing analysis of the house they have decided under the auspices of ten disciplines.**

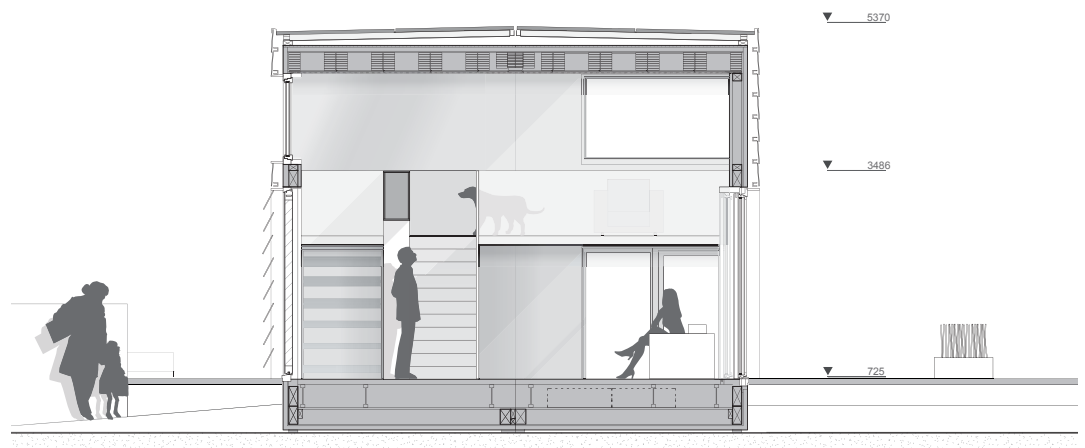
Climate change, rising energy consumption and the dwindling of natural resources call for new approaches in the construction and running of buildings. Sustainable building means reducing land use, minimising energy consumption in construction and operation of the building, meeting the requirements of future generations by ensuring the longest possible service life and relying on regenerative raw materials for building purposes. This was the background to Team Germany's submission for the Solar Decathlon 2009 competition, which serves as a pilot project to demonstrate the integral approach to planning.

The house – 'surPLUShome' – has numerous elements which make it possible for users to get away from the classic understanding of living requirements. It is based on a single-room concept whereby different atmospheric and thermal zones in space are defined. The integrative design and the flexibility of the multifunctional furniture in the centre of the room increase the quality of life to a significant degree. This furniture combines service functions like those of a kitchen, bathroom, stair and storage area. In addition, it incorporates all the technology for heating and cooling, hot water and electricity.

In the course of the development and realisation of the house, not only were a dynamic building simulation for the heat/cold energy requirements and a simulation of the grey energy (energy locked in the building components) carried out, a sustainability certification system was also calculated and suitable optimisation carried out in the light of the results.

The energy solution of the surPLUShome rests on two principal pillars. First, the minimisation of energy consumption through the use of passive, active or partially active systems or alternatively on the basis of energy generation.

The passive aspects include a good envelope to volume ratio, efficient thermal zoning, a well insulated and efficiently sealed building shell and good storage capacity. The building is insulated with vacuum insulation panels, so as to achieve the maximum usable area while adhering to the limited building area prescribed and meeting high insulation standards. Furthermore, the surPLUShome uses two different kinds of phase change materials in order to make up for the storage mass lacking in a wooden structure.





Short title:	<b>Team Germany – Solar Decathlon 2009</b>
Applicant:	Technische Universität Darmstadt [Technical University of Darmstadt], Faculty of Architecture, Department of Energy-Efficient Design and Construction, Professor Manfred Hegger Dipl.-Ing., M.Sc.Econ.
Total cost:	EUR 2,056,852.56
Government subsidy:	EUR 541,078.73
Project duration:	18 months

The phase change materials (paraffins and saline hydrates) are incorporated in the gypsum plasterboard panels of the walls and in the cavities of the ceiling, and have a melting point of 23° C. In the change of phase that occurs at this temperature, they can absorb the quantity of energy that is required for the cooling of the building in the space of a day. During the night this stored thermal energy is given out again.

As well as energy-efficient domestic equipment, the active systems include the thermal pump. This has integrated heat recovery, supplies hot water and covers all the heating and cooling requirements of the building.

The second pillar of the energy solution is to be seen in the maximisation of the energy yield. To this end the building shell carries different photovoltaic systems, both on the roof and on the façade. A combination of thin-film and crystalline solar cells makes it possible to generate a maximum of electrical power whatever the weather situation.

So the building shell is now a central component not only in design terms – in view of increasing energy requirements it becomes crucial from the point of view of technology as well. As well as the properties of the thermal shell which minimise energy losses, it now also forms an active solar layer. It takes its cue from the automated building utilities in regulating the light and thermal settings, as well as providing visual screening in the form of adjustable louvre slats. The façade and the roof carry photovoltaic modules with a total output of 19kW (peak).

Altogether 2.5 times more energy is obtained than the sum total of the house’s energy consumption for a two-person household, taking all aspects of operation (heating and cooling, ventilation and lighting, hot water and electricity) into account. The energy supply is largely due to the roof, which is fitted with highly effective photovoltaic modules based on monocrystalline silicons with an 18% degree of efficiency.





The façade is covered with CIS modules which have an 11% degree of efficiency. The façade design is based on the traditional shingle principle, reinterpreted in contemporary style through the use of photovoltaic modules. The façade of the surPLUShome is a showcase example of the use of integrated photovoltaic systems. The principal aim in view was to design a building with a homogenous and innovative appearance which would make a crucial contribution to energy production without neglecting the essential functions of a façade. ■



# Solar Decathlon 2010

Germany wins second and third prize!

Solar Decathlon Europe 2010 was the first instance of the competition's being held in Europe, and so can be seen as a continuation of the American event. Having been initiated by the Spanish Ministry of Housing and the Madrid University of Applied Sciences, the competition was naturally held in the Spanish capital. Four universities from Germany took part: the Hochschule für Technik und Wirtschaft Berlin [Berlin University of Applied Sciences], the Hochschule für angewandte Wissenschaften Rosenheim [Rosenheim University of Applied Sciences], die Hochschule für Technik Stuttgart [Stuttgart University of Applied Sciences] and the Bergische Universität Wuppertal [Mountain Region University of Wuppertal]. The Federal Ministry of Economics and Technology (BMWi) is the patron of the German entrants to the Solar Decathlon Europe competition, and has supported these university projects under the auspices of government energy research (the EnOB research initiative).

Building designed by the IKAROS Bavaria team





## Building designed by the IKAROS Bavaria team Rosenheim University of Applied Sciences

The building design of the team from Rosenheim University of Applied Sciences has been based on a modular structure. This results in an open and flexible ground plan. The building is designed for two permanent residents, while also making it possible for two visitors to be accommodated overnight and offering dining space for up to eight persons.

A central kitchen block serves as a meeting point in the centre of the generously designed living area. Here there is room for all necessary kitchen utilities and working equipment. A dining table is located next to the kitchen block. The length of this can be extended, or in case of need the table can be stowed completely away.

The crenellated façade, based on a completely new façade and sunshade design, gives the architecture of the building an individual and strongly expressive character.

The sunshade elements can also be adjusted to the needs and requirements of the building and its residents over the course of the day or year. This gives rise to a varying play of light and shade, so that the façade wears a different face at different times.

The energy concept relies on highly effective heat insulation, maximum airtightness and an efficient system of sunshades. During the hours of midday, when the sun is at its strongest, the sunshades can be raised from their underfloor base as high as the eaves. The continuously adjustable positioning of the sunshades gives rise to variable skylight apertures, so that the amount of daylight available can be determined by the residents' individual preferences.

The building is heated for the most part by passive systems. In the clear, cold hours of the night a water film is directed onto the inclined solar module on the roof. The water is chilled to around 10 degrees Kelvin by heat radiation and evaporative cooling; it is then stored in a reservoir and used during the day to operate the ceiling cooling system. To compensate for peak loads, an innovative duct fitted with a PCM latent heat storage material has been used. When operating in recirculated air mode, the system achieves a cooling output of 2 kW with a temperature difference of around 10 degrees Kelvin. Another notable feature is that the building's hot water comes not from solar heat collectors but from the process heat of a water/heat pump.



home+

**The building designed by the Stuttgart University of Applied Sciences**

The design submitted by the Stuttgart team combines traditional building fundamentals with modern materials and technologies. The starting point is a compact and very effectively insulated building volume, consisting of individual modules which can be arranged at a distance from one another. The resulting joints are used for lighting, ventilation and preheating in winter and for passive cooling in summer.

A special part is played here by the ‘energy tower’, which has a positive effect on interior climatic conditions through the interplay of wind and evaporative cooling. Here the long-established fundamental principles of traditional structures in hot dry regions of the world have served as a model – like the wind towers in Arab countries, or the patios that are common in Spain. In combination with the new materials and technologies available today, an architectural element has been created that gives maximum comfort with low energy consumption and at the same time has important implications for the appearance of the building in spatial and design terms.

The PCM phase change materials in the interior of the building increase the thermal effectiveness of the wooden modules. To cover the low residual energy requirements, the entire building shell is solar-active: the roof and the east and west façades have been given a second skin consisting of solar modules for the generation of electricity. This makes the building a ‘plus energy house’. The power shell produces electricity during the day, as well as supplying cooling by night. For this, water is pumped from a recooling system reservoir through pipes behind the modules on the roof. When heat is given off to the night sky, the modules cool down and absorb heat from the water that flows in the pipes behind them. Having been cooled in this way, the water is used for the regeneration of the PCM ceiling in the interior of the building, for the direct cooling of the floor and for the recooling of a small, recently developed reversible heat pump which is provided to cope with peak loads. This combination of a solar energy module and a ‘cold collector’ was specially developed for the building. The building’s modular structure would support further development into a variable construction system. ■



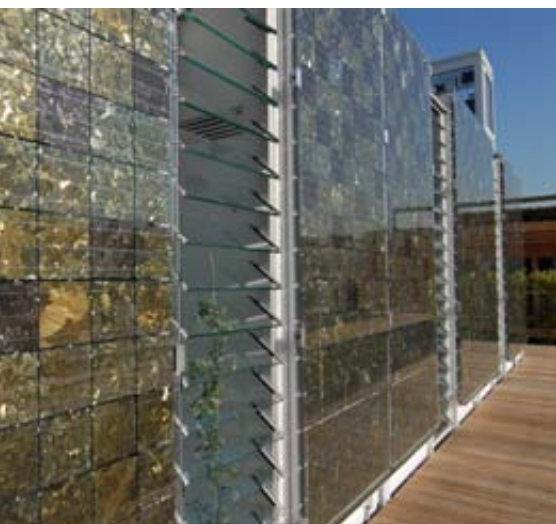
**The top three places**

1 LUMENHAUS	Virginia PI & SU	811.83 points
2 IKAROS_BAVARIA	HfW Rosenheim	810.96 points
3 home+	HfT Stuttgart	807.49 points

**Evaluation criteria**

Architecture	Max. 200 points
Solar system	Max. 200 points
Comfort	Max. 240 points
Social/economic aspects	Max. 160 points
Strategy	Max. 200 points





Photos: HFT Stuttgart

# Energy – environment – emotion

## More than just green building: the new SOLON headquarters in Berlin-Adlershof

SOLON SE is one of Europe's leading solar companies and a pioneer in the industry. It is committed to the fundamental principles of sustainable management and the consistent use of regenerative sources of energy. This exemplary company ethos has been put into practice at SOLON's new corporate headquarters in Berlin's Adlershof Science and Technology Park. The architecture embodies the spirit of the firm in an open and flexible working environment and dynamically effective building structure.

### Description of the building

The entire complex consists of administrative offices and production facilities on an area of around 36,000 square metres. The offices have a net area of around 10,000 square metres and hold workstations for some 350 employees (with around 28 square metres of working space). The building costs for the building amount to a total of ca. EUR 2450 per sq m (gross surface area), 34% of this being attributable to the building facilities. SOLON's production and office areas are separate from one another, but are linked by three bridges.

The office building should have an annual primary energy budget (for heating, cooling, ventilation and lighting) that is lower than 100 kWh (peak) per sq m (net surface area) per annum, so falling more than 50% below the limits defined by the Energy Saving Ordinance. At the same time it is hoped that from 2010 the entire premises can be operated on CO<sub>2</sub>-neutral basis in combination with a biogas cogeneration plant.

The building shell (a façade consisting of wooden elements) has a mean U-value of 0.8 W/(m<sup>2</sup>K) and protects the building by means of a sunshade system. The quality of the building shell forms the basis for a high standard of energy efficiency and a pleasant internal atmosphere. The façade should use little energy in production as well as drastically reducing the external heating and cooling loads, so as to dispense with conventional techniques.

In a close partnership between the architect, the energy designer and the company responsible for the project, Kaufmann Bausysteme [Kaufmann Building Systems], a completely prefabricated façade of wooden elements was developed. This incorporates all the necessary functions – thermal insulation based on triple insulating glass and vacuum insulation panels, sunshade systems with motor drive, window vents with opening contact and heating units.

The façade grid was set to a measurement of 1.35 metres, with a façade element consisting of two grid widths (2.7 metres). The room-high elements are divided into opaque and transparent areas. To vary the appearance, two different widths and arrangements of the opaque and transparent sections have been used. The transparent part of the outer circumference of the building shell amounts to around 60%. This value was calculated with a view to energy optimisation. The inner courtyards, on the other hand, have a transparency ratio of around 90%.

The opaque part of the façade is fronted by a weather protection grid extending vertically for the entire height of the building and made of wooden louvre slats, to keep out the rain and prevent illicit entry. Behind this there is a ventilation opening in the upper sector, and a convective unit is situated down below. This is integrated with the façade and serves for the rapid regulation of temperature.

The ceiling-high fixed glazing consists of triple insulation glass, with sunshades positioned on the outside. These are rail-mounted and wind-resistant, with a drive that is controlled by the BUS system. So as to keep the energy budget for artificial lighting to a minimum, the sun-





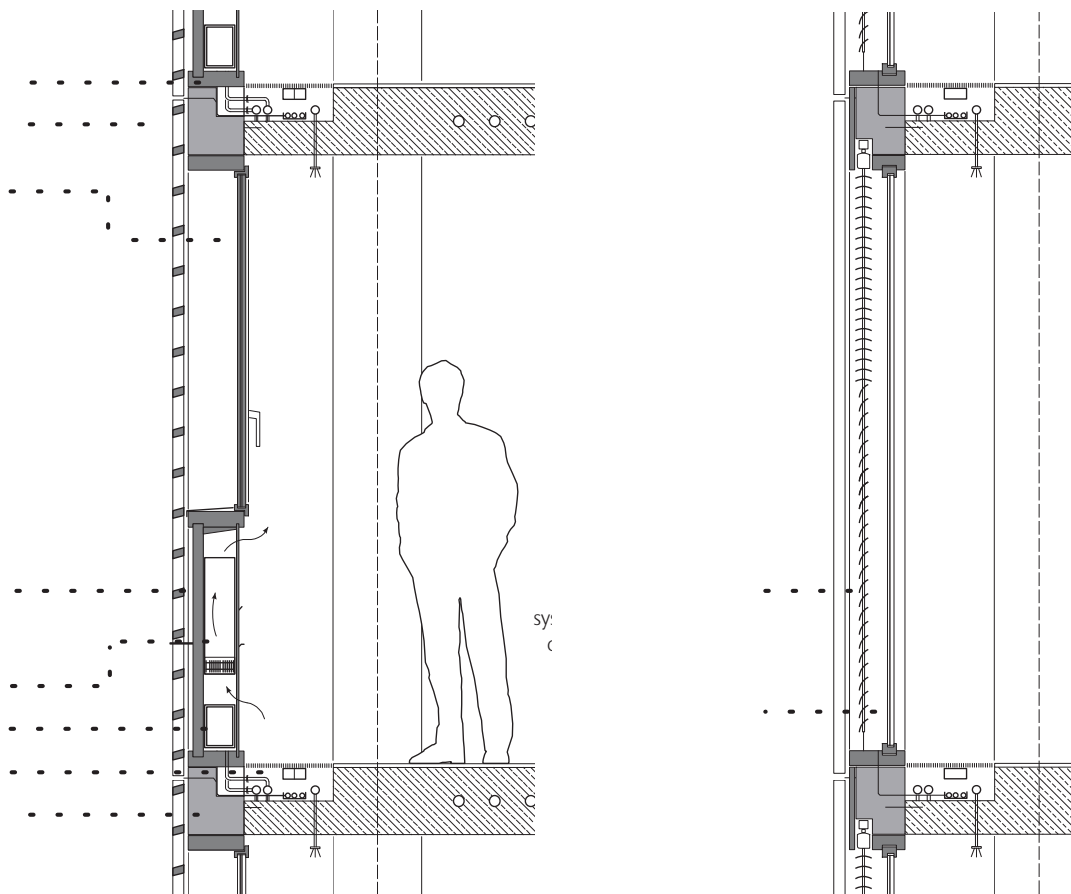
The new SOLON SE building in Berlin-Adlershof, south view  
Photo: Solon SE

External façade  
Photo: Solon SE

shade system has been designed with a daylight mode – that is to say, the upper third of the suspended units can be opened to allow light entry, while the lower part provides shade when in cut-off setting.

The façade profiles are of glued laminated timber (European fir), with a thermal bridge reduced design. In spite of the externally positioned sunshades, colour-neutral solar protection glazing has been used with a G value of around 0.32 and a light transmission coefficient of around 0.57. The triple insulating glass, made by Eckelt Glas of Austria, has a reflection coat-

ing on level 2 and a low e coating on level 5. With an argon layer and TPS spacers, it achieves a  $U_g$  value of  $0.6 \text{ W}/(\text{m}^2\text{K})$ . The vacuum insulation panels supplied by the Variotec firm of Neumarkt have a thickness of ca. 47 mm and achieve a U value of ca.  $0.25 \text{ W}/(\text{m}^2\text{K})$ . As a special feature for the Solon building project, the VIP manufacturer made a notable improvement in the creep behaviour of the units by developing a high-quality and exceptionally stable VIP element. A laboratory test by FIW Munich showed a thermal conduction coefficient lower than  $6 \text{ mW}/(\text{mK})$  over a period of 30 years.



Integrated timber element façade principle

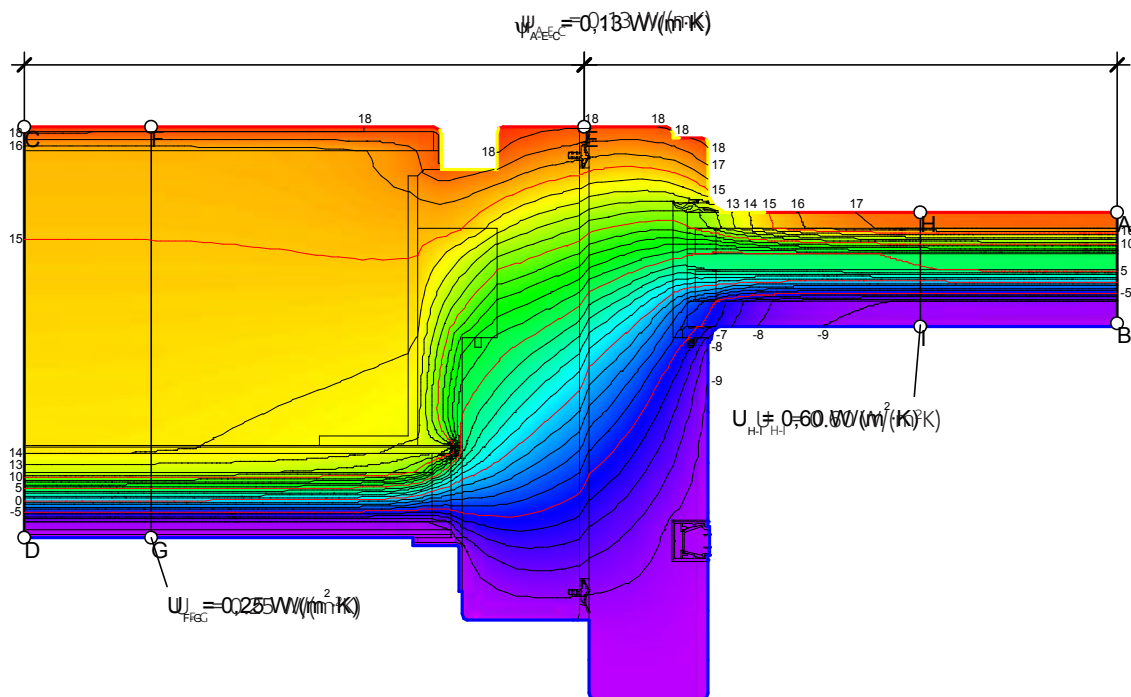


Architects:	Heinrich Schulte-Frohlinde
Energy design:	EGS-plan office, Professor M. Norbert Fisch D.Eng.
Monitoring: I	GS – Institut für Gebäude- und Solartechnik [GS Institute of Building and Solar Technology], Technical University of Braunschweig, Professor M. Norbert Fisch D.Eng.

The high proportion of fixed glazing in relation to the timber frame and the VIP elements made it possible for the excellent overall thermal conductivity coefficient (U value) of 0.68 W/(m<sup>2</sup>K) to be achieved in the façade. The entire façade has a sound insulation factor of around 43 dBA.

**Conclusion**

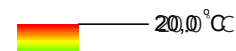
Some two years after the building went into operation, the first results show that the offices actually use less energy than the target values proposed. The current primary energy consumption total for heating, cooling, ventilation and lighting comes to around 90 kWh (peak) per sq m (net surface area) per annum – 10% lower than the ambitious target value of 100 kWh (peak) per sq m (net surface area) per annum. ■



Vacuum insulation panels, VIP, Konvektorkammer  
convection chamber

Holzpfosten  
timber posts

Dreifach-Isolierverglasung  
triple insulation glass



Thermal bridge reduced building shell – timber element façade with triple insulation glass and VIP elements

Source: qdb Lab GmbH

## How solar is the future of building?



»Anticipation is becoming a new design principle.«

Professor Jürgen Ruth D.Eng. holds the Chair of Structural Design and Solid Construction (II) at the Bauhaus University of Weimar. In this function Professor Ruth has spent five years as head of the FORMEK research group for the Appropriate Design and Construction of Fibre-Reinforced Plastics.

The faculty the professor directs was responsible for building what was at the time Germany's biggest updraft power plant and has also designed an energy-autonomous cinema (the Screenhaus Solar), as well as offering a master's degree in 'Archineering'.

**So, how solar is the future of building, Professor Ruth?**

The future of building will certainly be solar, if we understand the term 'solar' in a broad enough sense. If we take it as only indicating that energy is obtained from photovoltaics and solar thermal systems, this is too partial a view. If we take into consideration all forms of energy that have been left in the universe since the big bang and which are still carried by the sun today, then the future will certainly be solar.

Of course when it is a matter of solar building there are other matters involved as well. Cooling systems, electricity, hot water – and construction materials are a particular area of interest. Already today there are people who say that the biggest source of materials for the future is existing buildings. We will have to reckon with a shortage of resources, much more than is the case today. We need to be aware that the energy needed to produce construction materials is ultimately of solar origin. Everything is solar if you define the term widely enough.

**What are the most important themes of the future for building? What will we be talking about in five to ten years' time?**

Well, we are assuming that buildings are much too narrowly focused on the present. Buildings need to have more possibilities of being technically upgraded. Just compare a building with a car. There's no problem about installing the

most modern design of winter tyre when the vehicle is ten years old. But when it comes to houses, upgrading is phenomenally expensive. It should be made easier for future innovations to be incorporated in a building. And another important concern – there are buildings that are not all that adaptable in relation to the environment. We have different times of day and different seasons, and the only adjustment we make is to open the windows and switch on the central heating. We could make our houses much more flexible in relation to the environment, make them 'adaptive' houses. For example, winter gardens can be of variable size and can be used to capture energy. We are assuming that adaptive building will be an important theme of the future.

**Under the auspices of the research initiative you are working on a project concerned with active fibre composite materials for adaptive systems. Are adaptive systems in building structures and façades a new basic form of technology?**

Yes... Alterability has become a new requirement for buildings. We have to find ways of making buildings alterable. Fibre composite materials are one way of varying surface properties, making them actively controllable. These new materials have a place in the planning portfolios of the future. Compare today's buildings with the computer industry. With computers you can distinguish between hardware and software. In the buildings sector as well, in ten years' time with today's modern methods we should be able just to install the latest software to bring them up to the present-day state of the art.

**Lightweight construction methods have advantages in terms of flexibility, when it is a matter of changing the building or the choice of site. Is there an industrial demand for the adaptive systems you describe?**

There is no area where conversion is so frequently required as in industrial building. Today the

process generally involves just changing a support somewhere. Some years ago our students took part in a competition where a bridge had to be adapted to a clearance gauge located below it.

This was a quite unique situation, and only required on a few days of the year. Only an active adaptive system would meet the requirements. We believe that today's building structures are too static and too tied to present-day conditions. The progressive path is from adaptive to integrated and embedded systems. Anticipation is becoming a new design principle.

### How are university courses in construction engineering going to be affected?

At the Bauhaus University of Weimar we have created a master's degree in Archineering. Of course that is just an artificial term. But the course brings together architecture and construction engineering students. I see it as being particularly important that alongside the departments of architecture and construction engineering there should be an additional focus on energy planning. This is the only basis for the holistic planning and building of the future.





**What kind of house do you live in? Is it all you could wish for? If we look at building now from a quite personal angle...**

Well, of course I have to admit that my house doesn't illustrate any futuristic themes. It's about ten years old, and does what was expected of it at the time when it was built. Well, of course I have to admit that my house doesn't illustrate any futuristic themes. It's about ten years old, and does what was expected of it at the time when it was built. ■

Updraft power plant  
Photo: Tobias Adam, Bauhaus University of Weimar



Screenhaus cinema, Photo: Robert Held, Bauhaus University of Weimar







**Possibilities and opportunities of  
redeveloping for residential use inner city  
housing of the fifties, sixties and seventies  
that has become unprofitable and non-  
functional**

## **Demolition or redevelopment**





Short title:	'Demolition or redevelopment?'
Total cost:	€ 208,196.50
Applicant:	Professor Gert Kähler
Project Director:	Professor G. Kähler; blauraum architekten C. Venus Dipl.-Ing.;
in collaboration with	HafenCity University of Hamburg, Professor B. Kritzmann
Government subsidy:	€ 159,996.50
Duration:	1.1.2008 – 31.3.2009

**In various cities both in Germany and abroad, recent years have seen the redevelopment of office blocks of the nineteen-fifties and sixties for residential housing. This research project is aimed at the systematic investigation and assessment of these isolated efforts, with a view to determining whether there is potential for creating inner-city housing economically by redeveloping office buildings that have become uneconomical.**

### Object of the research project

A category of buildings regarded as problematic in all major cities today is that of inner-city office blocks from the early years of the federal republic and the reconstruction era. Many of these are left standing empty, and they are difficult to market. In view of the relative lack of variation in the layout (mostly dual corridor), the frequently limited surface area (in relation to the facility management and operating costs), and also because the design and ceiling height make them unsuitable for modern requirements, it is rarely possible to adapt them to the needs of modern office technology and office planning or it would be economically impractical to do so. As a result a lot of properties in this class are left empty. Their average rent is frequently less than that of new inner-city residential housing.

On the other hand, many city-dwellers, in big cities above all, are wanting to get back to the inner city without being able to find suitable or economically viable housing, because these inner city areas cannot be extended indefinitely. Even on areas that have recently been converted, the costs of government-subsidised social housing are still many times too high to be attractive to large sectors of the population.

The possibility of redevelopment thus offers numerous advantages:

- Reduction of the number of inner-city office blocks that no longer pay their way
- Increased availability of inner-city housing
- Countering the overspill of cities into the surrounding countryside, on the basis of intelligent inner-city development
- The creation of new living space in this way makes a lot of sense in terms of environmental and climatic considerations (use of existing resources, no new ground sealing etc.).

The main emphasis of the study was not so much on the overall statistics, but rather on the illustrative and practical investigation of individual projects in various cities, likewise selected for illustrative purposes.

- Major city, growing (Hamburg, Frankfurt am Main)
- Major city, shrinking (Dortmund, Bremen)
- Medium-sized city, growing (Münster, Karlsruhe)
- Medium-sized city, shrinking (Magdeburg, Kassel)

In these cities the real estate markets were investigated and buildings selected as a model that had redevelopment potential. This potential was then examined, in some cases with an outline solution being provided.

Photo: Katrin Schierloh



### Conclusions

- The technical requirements of a redevelopment project are the same as those that would be relevant to a comprehensive structural upgrading of the building as an office block, in keeping with today's technological and energy conservation standards. Before going any further, these need to be clarified first of all.
- Secondly, before embarking on any detailed consideration the legal situation needs to be clarified and/or it must be ascertained whether the city is prepared to support such a project, if necessary on the basis of exceptional regulations.
- Because of the different interest groups involved – and also because of the differences between the buildings in terms of age, state of preservation and location – there cannot be any 'royal road' to a decision. Demolition, use of existing property without major interventions (based on refurbishment), fundamental renovation as an office building or redevelopment as residential housing are all alternatives which must result from an open process of decision.
- The overall ecological balance is clearly advantageous. The reuse of inner-city real estate makes sense, even if major conversion measures are called for.
- The technical and design difficulties are not unmanageable. Acoustic problems can be solved and sanitary facilities installed, as well as partition walls, new façades and fire prevention features.
- Indispensable for successful redevelopment, both economically and from the point of view of building law, are the status protection of

the building in its entirety and the solution of the VAT problem and/or compensating subsidies from another quarter.

- The post-compaction of defined inner-city locations is an additional instrument for encouraging conversion for residential purposes, because in this way economically attractive housing can be provided.
- Key project statistics show that the project costs of a fundamental conversion with energy upgrade are comparable with those of a new building.
- Even when redevelopment and a new building come with an identical price tag, redevelopment will generally be financially favourable, because
  - the demolition costs can be dispensed with;
  - the construction time will be less, so lower costs will be incurred for intermediate finance;
  - the use of the land continues the same, even when today different legal conditions prevail.

A different matter altogether are questions of marketability, or whether the proprietor is at all willing to take an interest in a project of this nature. ■

# ‘The Old Village School Multiple House’

## From a vacant building to the Multiple House

Demographic changes are leading – in country regions above all – to an aged population and so to a loss of mobility. Over against this we see the increasing centralisation of services on municipal level, even including services that meet basic needs (shopping centres, doctors’ surgeries etc.). It is hoped that the vanishing village infrastructure can now be reactivated through the innovative multiple use of vacant historic buildings.

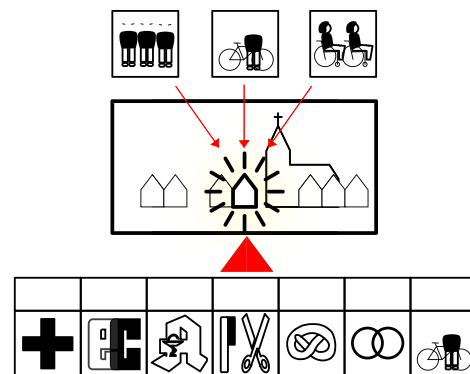
### Object of the research project

The aim of the research project is to develop a prototype building as a structural shell for various forms of use which can alternate in the course of the day’s rhythm. This is to help revive lost infrastructure and so improve the quality of life in rural districts. Only abandoned buildings are to be used – parish halls, schools, railway stations or secular buildings like old village inns. The main objectives are to stabilise the core of the locality, to install a social infrastructure and to identify and support the locality’s typology.

The Multiple House is an ecologically and economically acceptable answer to a complex of problem issues which are being generated as a

result of the increasingly restricted mobility of an ageing society in rural regions. The growing deficiency of quality of life is a kind of poverty, and it is increasing all the time. The loss of infrastructure and transport connections harbour the danger that whole population groups may be marginalised and excluded from public life. In the countryside it could lead to entire villages being abandoned.

The Multiple House – alternating uses even in the course of the day’s rhythm



It is hoped that the Multiple House may make it possible to compensate for the loss of mobility of the inhabitants by boosting the mobility of the ‘service providers’. These share the rent and costs of the use of the house as ‘fixed’ users, based on the ‘car-sharing’ principle. As the use of the premises can vary, adjacent villages with a network of Multiple Houses would in their turn offer an attractive working environment to doctors, food retailers, hairdressers etc., who for economic reasons can only visit a village once a week or once a month. The more villages join the network, the less distance has to be covered by the service providers, so their commitment to the scheme becomes more economically attractive. On all free days the premises are available for flexible use – coffee and chat, card evenings, slide shows and the like.

In small villages above all, a great deal depends on the voluntary efforts of the local inhabitants – it is up to them to get their village going.





<b>Project:</b>	<b>'The Old Village School Multiple House' – from a vacant building to the Multiple House</b> Installing Multiple Houses as a community support point for services and neighbourhood in rural areas and in the Stettiner Haff model region, an area particularly affected by demographic changes
<b>Applicant:</b>	rb architekten Leipzig
<b>Project Director:</b>	Jana Reichenbach-Behnisch Dipl.-Ing. Arch. (TU)

### Networks of Multiple Houses

The first target is the fundamental activation of the selected building premises by providing a basic set of features and furnishings: a 'bench' for sitting purposes in the central reception area, a 'counter' for the exchange of goods and stories, a closing locker-like cupboard system as a support point for regular users. The interior of the Multiple House needs to be simply furnished, but with modern technology and professionalism. The architecture should be typical of the region so as to strengthen the sense of identity of the village population and make them feel they are at home. Depending on the use envisaged, basically just one or two rooms are sufficient for the running of a Multiple House. In many villages today the primary schools are standing vacant. We demonstrate how, step by step, unused building premises can be reactivated and made dry, safe and warm. To begin with a few warm rooms can be supplemented by simple cold rooms – as accommodation for cyclists in summer, for instance. All this is illustrated in practical terms by an innovative energy strategy, an estimate of the building costs, a funding application and floor plan diagrams which can be presented based on the example of various actually existing buildings.

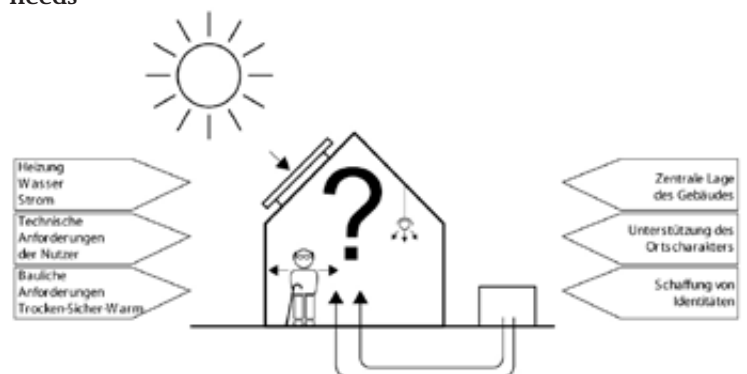
With the particular aim of meeting the fixed expenses that the running of a house involves, we have pointed up possible 'sponsoring' options – like real estate tax concessions by the local authorities, special conditions for the financing of the project from the banks or the waiving of connection charges by the utility companies. Another important factor is the personal support of 'fixed users' like the post office or the local savings bank, who will include the Multiple House in their network of service points in cooperation with the council offices. In the course of the work, interviews and workshops were held with the principal players and decision-makers in the fields of politics and business, and four villages in the Stettiner Haff Model Region in the northeast of Germany were actively involved. In this way the idea of the Multiple House was tested in practice step by step and right from the start of the project. With the help of recommendations for action, a building passport and a catalogue of requirements and criteria, the parties involved as well as the mayors and

local councils are being provided with working instruments for the installation of Multiple Houses.

### From a vacant building to the Multiple House

The Multiple House in the village is the centrally located building which catches the eye with its regionally typical design and typical local features, and makes an inviting impression on local inhabitants and visitors alike. It can easily be identified by visitors to the village, even when just driving through. Both village residents and visitors will find a place providing information, communication, service and a sense of neighbourhood, with the possibility of the building being used for different purposes even in the course of the day's rhythm.

### Criteria for the Multiple House – fundamental requirements and regional needs



### Conclusion

'The Old Village School M.H.' – the simple addition of the 'M.H.' in the name identifies the building as a Multiple House both locally and beyond the region.

Thus it maintains its identity and shows that it has a 'history'. The 'Multiple House' label should also help create a basis in building law and contract law to simplify and speed up the planning application process. The object of affixing a label is the effect of familiarity, the label being an effective tag for publicity purposes, and it is also designed to encourage the formation of a supra-regional network. As a next step, pilot projects are to be started in the Stettiner Haff model villages. These will be jointly developed and managed in a first network of Multiple Houses. ■

## A future for empty spaces?

Jana Reichenbach-Behnisch, architect, rb architekten, Leipzig



»With the Multiple House approach we are deliberately trying to counter the negative consequences of centralisation.«

Since January 2007 Ms Jana Reichenbach-Behnisch has been head of the rb Architekten architects' office, based in Leipzig's old carpet works. Dating from the Gründerzeit epoch, the old carpet factory stands today for the active conversion of industrial waste land. Creative spirits have here succeeded in redeveloping and reusing vacant building structures. Ms Reichenbach-Behnisch is engaged in various research projects in the local countryside, especially in the Stettiner Haff district.

**With the old carpet works you have shown how empty premises can be reoccupied. Is this change in the use of a building a model for whole regions, like the Stettiner Haff region for example?**

It can definitely be a model for an entire region. The carpet works is a very large industrial complex with a surface area of 6000 square metres, which makes comparisons difficult. But the problem of vacant buildings is found in a great many forms and regions, especially in eastern Germany.

If we contemplate the different kinds of populated area, from the metropolis to the village, in the last resort our idea is really capable of being extrapolated. It is a case of the management of empty buildings with the addition of new uses, which however are actually identical with the 'old' use: where carpets were produced in the past, now we find the productions of creative industry.

**In Germany we can observe two major internal migration processes. Only limited possibilities of action are available as a means of influencing these processes. Why shouldn't we simply let people move where they like?**

Yes... That is an interesting question. Speaking off the cuff, you would be inclined to agree that people should simply be allowed to move. People are free individuals after all, and should be free to make their own decisions. But of course some cases of internal population migration can be viewed with a critical eye. The migration processes that we see in the Stettiner Haff region, in particular, are a cause for concern, as migration is only open to certain sections of the population and other groups are marginalised completely. And it is hardly to be expected that the cultural landscape of the Stettiner Haff region is going

to be repopulated as a spontaneous occurrence. With our work we aim to provide a creative approach that will make it possible for people to stay where they are. The aim is to stabilise the region. The artificial idea of a region of wolves, bears and bison is not an option, but it amounts to a task in terms of the cultural landscape – with its villages, castles and historic tree-lined avenues. When I heard it said that we should give up four out of five villages, I ask myself who is going to want to live, in that case, in the last village? This is not the kind of approach we work with, nor is it my personal brief.

**The multiple use of houses is your proposed solution for small communities, so as to enable vacant buildings to be used once again. What developments have you been able to identify in the areas where you have been active?**

With this research initiative in particular, we concentrated on rural areas. In the Stettiner Haff region we have been able to establish that there are a lot of people moving away, especially young people, because of the lack of work locally. People are admittedly prepared to commute quite long distances now, but when you get beyond a certain distance, this just isn't an option for young people any more.

We have noticed massive centralisation, especially in rural areas, of everything that makes a difference to the locality in terms of quality of life: food stores, services and council offices are now as far away from people as the theatre, libraries and museums. Exacerbated by the decreasing mobility of the inhabitants, there is a growing spiritual and cultural poverty and the lack of a sense of neighbourhood.

With the Multiple House approach we are deliberately trying to counter the negative consequences of centralisation. It should again be possible to access a wide range of services locally. Retailers, doctors and hairdressers should divide a house in the village between them, a day at a time. This house is a new place of communication. Even neighbourhood requires space.



In talking to people we have repeatedly found that they feel rooted in the region, and want to stay here – not just old people, but the young as well. There are often historic reasons for this. Above all in rural regions, the land under your feet still has a special significance.

**What measures or developments can induce people to stay in regions that are emptying?**

The word ‘homeland’ is important. Making this word meaningful again, making it something you can experience, that is a part of our work. We want quite consciously to activate houses that are standing empty. They must have a history which can be taken on board by the village inhabitants, to which they continue to add further chapters. Another point is the increasing centralisation. Here, in our view, a line needs to be drawn, as when you get beyond a certain scale the process goes into reverse and becomes uneconomical. We cannot ourselves make it our principal remit to create jobs in the region, but we are looking for a way forward through structural change – encouraging the development of a service society. Here we also have a particular interest in the growing 50+ generation. Developing creative services in this area offers new opportunities for a service society.

**What kind of house do you live in? ... seeing that our research programme focuses on the future of building?**

‘Zukunft Bau’ – Future Building – yes. Actually I live in an old house dating from 1911, which has always belonged to my family. I live there with my daughter, my husband and my 85-year-old aunt. A style of living, as you might say – something we recommend for our villages as well. ■





**Carpet works:  
a future for empty spaces**



# fertighauscity5+

## Back to the city

**The high flexibility of production methods in timber frame building, which supports building typologies beyond that of the freestanding single family house, can now, as a result of the reform of the State Building Regulations, be used for the creation of urban housing in timber frame design. But there still are not enough suitable ideas for multi-storey wooden buildings which would take advantage of the special features of timber building systems, like prefabrication, construction time and flexibility of production.**

Living in the city has many advantages. If you want to plan and design your living space individually, however, you are faced with a major problem: in concentrated urban residential areas, users rarely have much influence on the planning of their future home. The consequence is that households wanting to build a house, including many who are city-dwellers by conviction, migrate into suburban areas. There is a lack of suitable concepts for urban living which would unite individual housebuilders under a single umbrella.

### New social models

At the same time, society too is in flux. The classic nuclear family has long ceased to be the principal player. New and alternative social constellations, from the single apartment to sheltered housing, value the urban environment. In recent years these groups have become increasingly significant in the search for individually adaptable living space.

### Five timber storeys in the inner city

As a result of the current climate debate, wood has now also been rediscovered in Germany as a CO<sub>2</sub>-neutral construction material. Industrial prefabrication in housing construction currently concentrates with its ecological concepts almost exclusively on single-family houses in suburban areas. These houses are for the most part constructed in some form of timber frame design. Here the ultra-flexibility of the production methods used in timber building can also support typologies other than that of the freestanding single-family house.

The reforms in the State Building Regulations now allow up to five storeys in timber construction under Buildings Class 4. Although the legal foundations have been created for multi-storey timber frame designs as a result of the new

Model Building Regulations and Model Timber Building Directive, there is still a certain reserve in this area towards multi-storey timber building concepts on the part of house-builders, planners and building firms. Among the reasons for this is the lack of strategic ideas for technical and typological implementation, with a view to making it possible for wood to be used for the first time in grand style in the inner city.

### Individual prefabrication with user participation

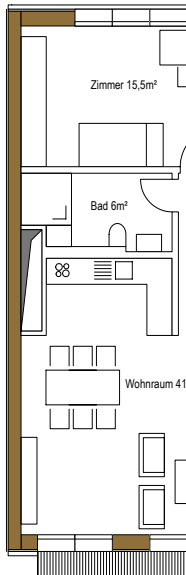
The fertighauscity5+ research team has set itself the target of developing a model to support wide latitude of design in up to five-storey urban building types.

‘Individually configured prefabrication with user participation’ is their central slogan. For development purposes it was necessary to bring together a wide range of disciplines under a single umbrella. From building project consulting, project direction and architecture through to fire protection, building utilities and timber construction, a number of different specialists have come together in a research association with the aim of working to develop a holistic concept extending from target group analysis to technical realisation.

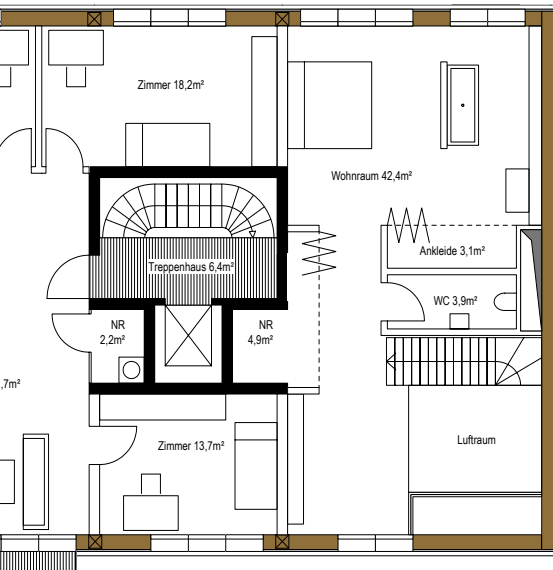
### Conclusion

#### Five prefabricated storeys made to measure

The result has been the creation of strategies for multi-storey urban houses in timber frame construction, issuing in an all-round architectural concept. These strategies have been designed in such a way that the widest range of user groups can exercise as much influence as possible on the shape of their future home, as early as in the planning stage. On the basis of three socio-economic target groups, the research team developed an adjustable realisation model. The







Regular floor plan offering great flexibility.  
 Visualisation: TU Braunschweig [Technical University of Braunschweig]



model stands in relation to a coordinated set of practical instructions for the project planning, designed to serve as a guiding thread for planners and builder developers. This gives a systematic account of planning procedures, so simplifying the decision-making process for the builder. Moreover, production methods for creating the individual components have been developed to a high pitch of technological sophistication, making it possible for layouts and façades to be planned to an individual design. The parts can be prefabricated, and then installed precisely and rapidly on the building site. From the freestanding point block to the plugging of building gaps, and extending as far as the linear building, fertighauscity5+ is the five-storey prefabricated house that can be made to measure and built anywhere in the whole of Germany.



Model:  
 The solid stairwell is the backbone holding the structure together...



... and the prefabricated wooden storeys are hung on the stairwell core.



The façade shows the different use units.

Typology and architecture	TU Braunschweig IIKE, Institut für Baukonstruktionen und Industriebau [Institute for Building Structures and Industrial Building]
In collaboration with	BWK(BauWohnberatung Karlsruhe)
Building utilities/energy design	TU Braunschweig IGS, Institut für Gebäude und Solartechnik [Institute for Buildings and Solar Technology]
Fire protection, bearing structure	TU Braunschweig IBMB, Inst. für Baustoffe, Massivbau u. Brandschutz [Institute for Building Materials, Solid Construction and Fire Protection]
Design/process	O.Lux Holzbau [O.Lux Timber Construction], Roth
Author	Daniel Rozynski Dipl.-Ing.: IfuH – Institut für urbanen Holzbau Berlin [Institute for Urban Timber Building, Berlin] and IIKE TU Braunschweig

# ImmoWert

## Integrating sustainability aspects in the valuation and risk assessment of individual properties and building complexes

In recent years sustainability has become an increasingly important factor in the real estate sector. Whereas the technical requirements for a sustainable property and the practicalities of making a building sustainable have already been researched, there has still been very little work done in the economic sphere, especially in relation to the specific risk of properties, value assessment and the application of the latter in terms of international accounting principles.

### Object of the research project

The ImmoWert project has been concerned first of all to cover the wide spectrum of building features that have implications for sustainability, and to investigate the risks associated with these. A special area of interest within the catalogue of topics with relevance to sustainability is represented by the area of energy efficiency and greenhouse gas emissions. This is the area that building experts see as holding the biggest potential for savings. Current energy consumption in old buildings can come to as much as three or four times as much as that of new buildings. Significant reductions can thus be achieved by an energy upgrade in most old buildings – almost 30% by 2020, starting from the year 2000, according to the calculations of the World Climate Council [1]. In this connection the biggest savings can be reached in residential buildings that are more than 30 years old [2]. No technological improvements on today's state of the art would be required, and even a modest rise in energy prices would be sufficient economic justification for the required energy upgrade measures. Above all the effects of energy price rises and fluctuations (price variation risks) in future should give the biggest boost to people's willingness to carry out modernisation measures with energy implications, for purely economic reasons.

The starting point for qualitative risk assessment is represented by the determination of the features of a property that have an effect on the risk. This involves determining what are known as megatrends, based on trends that have risk implications.

In the light of these trends it becomes possible to outline the resulting implications for the housing industry, and translate them into

concrete requirements for existing buildings and buildings management. These can affect the value of a property in either an upward or downward direction, and not infrequently show cross-correlations. Generally speaking, and especially in the eyes of the finance industry, a symmetrical idea of risk predominates, so that the megatrends described not only may reduce the value of a property (downside risk), but can actually increase it (upside risk).

It is the task of a risk management system to minimise the downside risk affecting property values on the basis of inadequate sustainability, and to use risks of this nature to increase the value. This asymmetrical conception forms the basis of most risk management methods, but not necessarily of methods of valuation. The present essay presents an innovative approach to the asymmetrical consideration of risk in value assessment. For this purpose a special concept has been developed, based on the 'innosys' system with the addition of sustainability criteria. A preliminary indication of the implications of the findings so far achieved for international accounting methods has been given, and the necessity demonstrated of the incorporation of sustainability aspects in valuation models.

- [1] IPCC, 2007, Climate Change 2007 – Synthesis Report, on the IPCC website, [http://www.ipcc.ch/pdf/assessment-report/ar4\\_syr.pdf](http://www.ipcc.ch/pdf/assessment-report/ar4_syr.pdf), accessed on 19.11.2009
- [2] McKinsey & Company, 2007, Kosten und Potenziale der Vermeidung von Treibhausgasemissionen in Deutschland [Cost and Potential of the Avoidance of Greenhouse Gas Emissions in Germany], on the website of the Bundesverband der Deutschen Industrie e.V. [Federal Association of German Industry], [http://www.bdi-online.de/Dokumente/Umweltpolitik/Klimastudie\\_BDIundMcKinsey\\_KostenundPotenzialderVermeidungvonTreibhausgasemiss.pdf](http://www.bdi-online.de/Dokumente/Umweltpolitik/Klimastudie_BDIundMcKinsey_KostenundPotenzialderVermeidungvonTreibhausgasemiss.pdf), status as at 25.09.2007

This necessity has been taken into account with the description of the status quo of valuation in the real estate sector in Germany, on the basis of a short presentation of the various valuation methods and explanation of their specific details with reference to market value, property return and residual service life. It has been demonstrated that even in this ‘old world’ of valuation it is possible for sustainability considerations to be taken into account, as was done later in the course of the project with reference to energy. Following this a new approach from the derivatives sector has been selected, the Real Option approach, as a possible addition to the Discounted Cash Flow (DCF) method in real estate valuation. An introduction is given to the Real Option method, which has already demonstrated its analytic effectiveness both in real estate valuation and in the value assessment of regulations in the energy sector. The core of the subsequent considerations and modellings is the idea, derived from the option markets, that flexible options of action – in this case, being prepared to meet future energy price rises and fluctuations – and the associated energy invest-

ments are not primarily to be understood as cost drivers but rather as an insurance premium. These considerations relating to risk assessment and valuation have then been completed by the extrapolation of certain central aspects to international accounting practice.

#### Conclusion

The findings of the research project represent areas of sustainability in real estate that to a large extent have been uninvestigated hitherto, and should offer the housing and real estate industry both a basis for discussion and first recommendations for action. For the parts dealing with risk analysis and portfolio management, the development of methodological principles has been supplemented by the elaboration of practically applicable solutions, which have then been tried out in practice with selected partners. Within valuation, based on the causal model for the valuation of a sustainable building, conclusions have been modelled for the value of an existing property. ■

<b>Short title:</b>	<b>ImmoWert</b>
Applicant/researcher:	University of Stuttgart, Betriebswirtschaftliches Institut [Institute of Business Management], Division III – Finanzwirtschaft [Finance], Professor Henry Schäfer, Christian Gromer, Dipl.-Ing., MBA
	Karlsruher Institut für Technologie (KIT) [Karlsruhe Institute of Technology], Faculty of Economics and Ecology in Housing Construction, Professor Thomas Lützkendorf, Christoph Rohde Dipl.-Wirtsch.-Ing. [Master of Engineering Management]
	LBBW Immobilien Management Wohnen [Residential Real Estate Management], Dr Christian Jaeger
Total cost:	€ 207,188.84
Government subsidy:	€ 128,646.99
Project duration:	01.11.2008 to 31.03.2010



# Holistic integration and optimisation of the planning and realisation process for forward-looking and sustainable industrial buildings

## Starting position

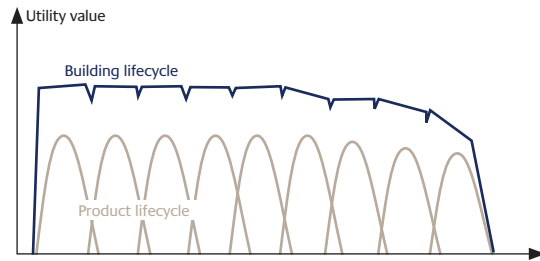
The shortening of product lifecycles and increasing global competition face industrial firms with constant new challenges (1), (2). The factory building is becoming a significant competitive factor, as it makes an important contribution to an industrial firm's being able to react to changing requirements, as well as determining what investments are needed for the purpose and what costs will be incurred over the lifecycle of the building (3).

## Object of the research project

Against the background of these changes in the basic conditions, the objective has been to provide support for the planning and realisation of industrial building by offering a holistically oriented set of planning guidelines. With a view to improving the coordination of the interfaces right from the start, the research project was managed by an interdisciplinary team of architects and factory planners from the Technical University of Braunschweig, with the support of numerous representatives of industry and institutes of other universities.

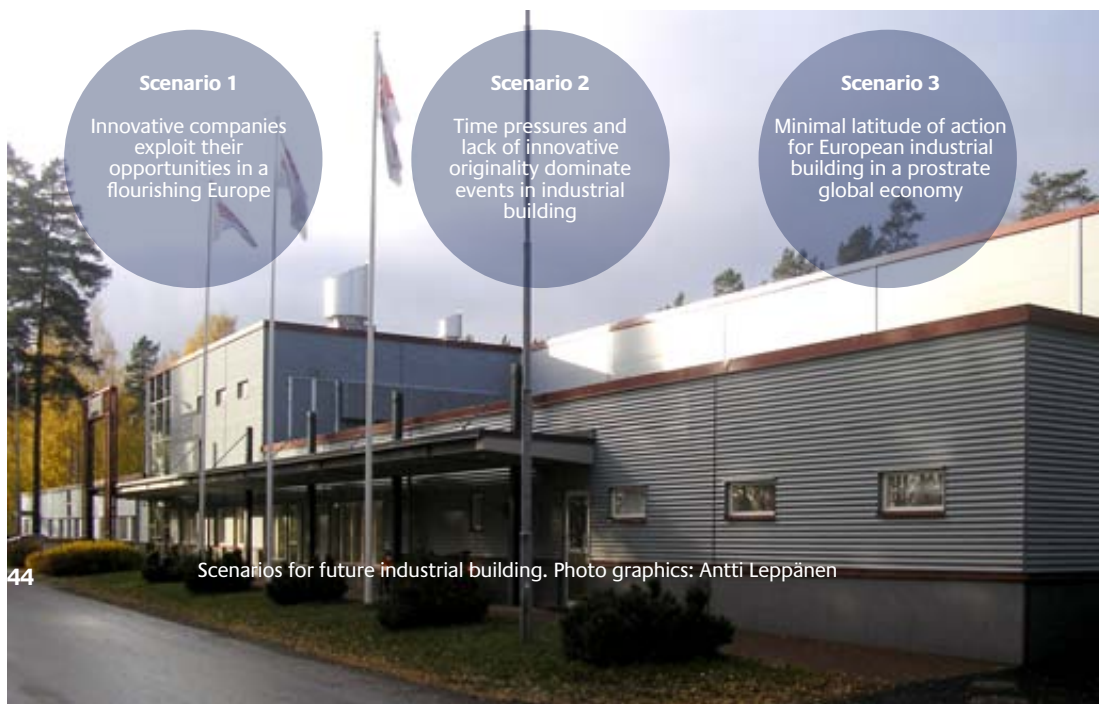
The basis for the elaboration of a set of planning guidelines for future industrial building has been the formulation of possible requirements and developments. With the help of scenario management (4), the research project developed the three scenarios shown in Diagram 1. Each of these scenarios was taken as a starting point for the derivation of requirements for future industrial buildings and planning processes, which in

turn yielded a basis for the development of the set of guidelines. In order to do justice to the future requirements for industrial buildings, it is not enough just to contemplate the investment and the state of the building at the time when it is first commissioned (5). More important than the short-lived target state at the time of commissioning are the development of the building over the entire lifecycle and the resulting lifecycle costs.



Representation of product/building lifecycles

Whereas generally speaking only the lifecycle of an individual product is considered, in the planning and realisation of an industrial building not only the lifecycle of the building itself but also the lifecycle of the production operations that take place there must be taken into account (6). As shown in Diagram 2, a future-oriented industrial building must be in a position to support as many production lifecycles as possible while maintaining a high utility value for the building. The best way to achieve this is by improving the building's adaptability (6, 7).



### Scenario 1

Innovative companies exploit their opportunities in a flourishing Europe

### Scenario 2

Time pressures and lack of innovative originality dominate events in industrial building

### Scenario 3

Minimal latitude of action for European industrial building in a prostrate global economy

The three scenarios have been taken as the basis for the development of a planning system. As well as considering the various scenarios, the object was to improve the future capability of the buildings and the process quality during planning and construction. In this sense the planning system aspires to offer a holistic application-oriented and practically useful set of guidelines for project developers, planners and builders.

For the attainment of these goals, industrial-building-specific fields of action have been identified and thematic areas allocated to them with suitable key tasks. The fields of action are concerned with the questions WHAT is being planned (an industrial building) and also HOW it should be planned. Here the fields of action are not independent but are correlated with one another. Based on the structure of the thematic areas, as many as 27 methods, aids and tools are made available to the user to support the execution of key tasks.

As a supplement to the planning system a catalogue of strategies has been worked out, designed to lead to a future-oriented structure for industrial buildings. With the help of an analytic method the attempt has been made to map all aspects of the building structure which are relevant to its future capability and embody these in a catalogue of requirements.

For the evaluation of the requirements, 23 industrial building projects have been investigated and a structural analysis carried out using the location, use and building data arrived at. By means of an assessment of the project-related data following the criteria of the catalogue of requirements, case-specific requirement profiles can be revealed. These can then serve as the basis for the derivation of strategies for the realisation

in building terms of the requirements profile. After this, based on the case-specific findings, a structural typology and catalogue of strategies for future-capable industrial buildings has been worked out. The classification of the individual strategies in the top-level catalogue of strategies makes it possible to recognise the typologies of future-capable industrial buildings. An extract from the catalogue of strategies is shown in the following diagram.

### Conclusion

The set of planning guidelines developed here makes a contribution to the improved planning and realisation of industrial buildings. The planning system that has been worked out takes into account, as early as in the planning stage, the many-sided influences and goals to be found in the course of the lifecycle of an industrial building. Numerous methods are offered to the user which systematically support the realisation of the prioritised thematic areas. The catalogue of strategies makes it possible for users to take the different execution options into account and classifies these in the light of case histories. ■

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Industrial partners: Bauforumstahl (BFS) e.V. [Building Forum Steel, Regd. Assn.], Forschungsvereinigung der deutschen Beton- und Fertigteilindustrie e. V. [Research Association of the German Concrete and Precast Parts Industry, Regd. Assn.]; Gesamtverband Dämmstoffindustrie [General Association of the Insulating Materials Industry], Hochtief Construction AG, M+W Zander Group

Fire safety systems in big building complexes frequently give the alarm. To find the alarm that has been triggered, printed fire brigade route plans are used. In view of the frequency of building modifications, these are rarely kept up to date, so that the fire brigade teams may have to find a new way into the building themselves when they arrive on the scene. This wastes valuable time which might have been used to save lives.

## Indoor navigation systems

<b>Project:</b>	<b>Context-sensitive RFID building navigation system</b>
Research institute:	Institut für Numerische Methoden und Informatik im Bauwesen [Institute for Numerical Methods and IT in Building], Technical University of Darmstadt
Project Director:	Professor Uwe Rüppel D.Eng.

The ultrasensitive technology of fire alarm systems results in frequent false alarms. The bigger the building, the more often these occur. For example, something like 3500 alarms are given at Frankfurt Airport every year. Printed fire brigade route plans represent an inadequate tool, in view of the fact that they are often out of date and do not help the men to get their bearings in the building. It becomes almost impossible for team leaders to keep track of the position of team members inside the building, as individual firefighters will have to be contacted by mobile phone.

The object of this research project on context-sensitive RFID building navigation systems was to develop methods for indoor location and navigation, so as to make it easier for emergency teams to find their way when deployed inside a building. The fire brigade's current printed route plans can be supplemented by digital building plans, generated from a digital model with the help of BIM (Building Information Modelling) techniques. These can be used on mobile terminal devices (like a Tablet PC for instance) to facilitate navigation.

The principal focus of the research work was first of all on the development of suitable location methods for determining the position of members of an emergency team when deployed indoors, and secondly on the further development of RFID technology with a view to providing additional help for finding one's way and supplying information to team members in a spatial context. This would include information that the team might need on such matters as the location of combustible materials and high voltage power installations. The application scenario in this research project comprises location

operations within buildings. Here GPS cannot be used as in outside areas, or can only be used with some difficulty [Eissfeller et al., 2005]. Numerous techniques have been developed for indoor location purposes in recent years, but in view of their specific characteristics they are only suitable for certain environments or certain spatial dimensions. Hitherto no technology has been developed which would be comparable with GPS as a universal system suitable for use indoors.

The research project analysed various different location techniques. Three of these were selected, each suitable for different environmental conditions [Rüppel and Stübbe, 2007, Rüppel and Stübbe, 2008a and Rüppel and Stübbe, 2008b]. The objective of the research project was to use a multimethod approach, based on RFID, Ultra Wide Band (UWB) and WLAN location as the basis for the creation of an Indoor Navigation Integration (INI) platform (see Diagram 1), which would first of all, depending on the situation, combine RFID-based location with UWB and WLAN location, and secondly would supply this information to mobile terminal devices on site in case of the alarm's being given. Information that the emergency team needs to know will be shown context-sensitively, i.e. in the appropriate spatial context.

The WLAN, UWB and RFID location components were installed and tried out in test environments at Frankfurt Airport and at the Institute for Numerical Methods and IT in Building. Here we had recourse to existing systems supplied by the Ekahau and Ubisense firms which met the requirements to an appropriate extent. These systems are linked to the INI by means of web services.

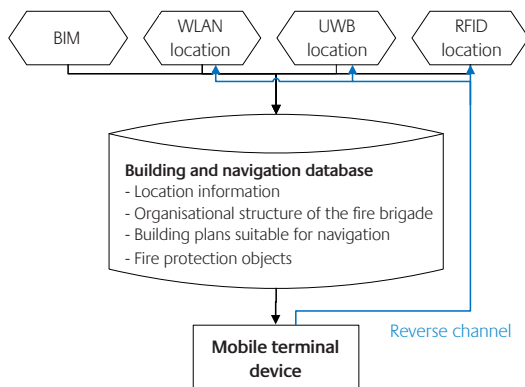




2D representation for firefighters

To make RFID location possible, active RFID tags with a UHF frequency of 868 MHz and 8 kB memory supplied by the Identec Solutions firm were tested. These can be read with a Compact Flash RFID Reader. This makes it possible to reach a sufficient indoor range with a reliable signal, supporting precise location in basements and underground parking areas.

A first version of the system was created and realised in the form of a prototype. All emergency operations are modelled on a database and held in readiness. The organisational structures of the emergency teams can also be managed. The BIM applications used by the prototype for 2D and 3D representation purposes are shown below.



Indoor Navigation Integration platform [Rüppel and Stübbe, 2008b]

To make it possible for fire brigade plans to be generated dynamically, a solution was developed and realised involving the automatic import of building data from BIM systems (in this case, CAD and facility management systems). Here both rooms and objects – like smoke detectors or fire alarm control centres, for example – can be exported and shown on mobile terminal devices.

**Summary and results**

Under the auspices of this research project on context-sensitive RFID building navigation systems, methods were developed for the indoor location and navigation of emergency teams, making it easier for them to find their way when deployed within buildings. The airport fire brigade at Frankfurt Airport was taken as an example. The methods developed were evaluated in a practical partnership with Fraport AG and Bureau Veritas Brandschutzservices. From this it emerged that location technology only proves insufficient in view of the varying size of buildings and rooms, and that this problem can be overcome with the help of a multimethod approach and through the Indoor Navigation Integration platform developed by the project. ■

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Photos: TU Darmstadt

# Graduated building components

## Production procedures and areas of use for functionally graduated building components in construction

### Occasion of the study/starting position

The objective of this research project has been to transfer the idea of the functional graduation of materials, which has already been used successfully in other engineering disciplines like aviation and space travel [1], to the construction industry. Functionally graduated building components show a continuous change of properties in their cross-section (Diagram 1). The property that varies may be the porosity or concentration, the fibre content or the ratio of materials (in terms of an alloy or blending of substances).



Reticulated polyurethane foam, source: ILEK

Graduated materials make it possible to achieve a higher degree of material efficiency, in that the composition of the materials will be adapted to local requirements. This is a useful alternative to measuring an entire building component in the light of its most heavily stressed point and designing it accordingly. The flowing or graduated change of phase simply removes the weak point, as for example with various thermal extensions on the limiting surface of functional layers, and so makes it possible for different functional zones to exist in a building component that consists of just a single material. Porous areas improve heat insulation, a concentrated texture keeps out water and damp, and local fibre reinforcement can take place in areas of exceptional stress.

### Object of the research project

Under the auspices of this research project, various classes of construction materials (concrete, textiles, wood, metals and polymers) and pos-

sible production methods and areas of application (bearing structure, building shell, joining technology) were investigated for functionally graduated building components and evaluated accordingly. Evaluation of potential production methods and their practical use in the construction industry will be followed by initial trials with a view to the manufacture of prototypes and sample components. This will be tested in relation to the relevant key statistics for the given material. Both static and construction physics tests are being carried out to this end.

The objective of the project is to evaluate the new design possibilities offered by graduated materials, seeing these from the architectural angle as well, and to develop proposals for their use in various areas.

### Concrete



Top: testing varying-density aerated concrete  
Bottom: homogenous concrete mixtures in levels of graduated density for material testing [2], source: ILEK

Concrete predominates as a construction material in the industry, and so offers considerable potential for material and energy savings. Thus it was the most important material that the research project investigated (see Diagram 2). The relevance and urgency of the potential material and CO<sub>2</sub> savings in construction was confirmed by direct feedback coming from several leading companies in the industry who were involved in the project as cooperation partners.



4-point bending-tensile trial, source: ILEK

As a first step, the fundamental technological properties of concretes of varying porosity (with consequent variation of bulk density, thermal conductivity and stiffness) were established (see Diagram 2 below). The project succeeded in developing mixtures reflecting a range of properties from extremely hard to ultra-light (bulk density < 400 kg/m<sup>3</sup>).

Through the use of highly porous mineral aggregates it proved possible to develop a concrete mixture with a thermal conductivity well below that of an EPS material like polystyrene. This exceptionally light concrete makes it possible, based on the idea of material gradation, to achieve purely mineral concrete external walls that are less thick than comparably effective thermal insulation composite systems, while at the same time improving recyclability and saving resources and mass to a significant degree.

In the second major area of use, intermediate floors, it was also possible to demonstrate that varying the concrete density in relation to stress in the cross-section of the component could save more than 50% of the mass without loss of bearing strength (see Diagram 3). This reduction of mass would be associated with cement and CO<sub>2</sub> savings of the same order of magnitude.

The production technology required represents a particular challenge in this connection. Under the auspices of the project, procedures for the production of different component geometries (including the distribution of varying properties over one axis or two or three) are being designed and subjected to initial testing. This makes it possible to scrutinise the variation of porosity and fibre content and the proportion of other concrete admixtures (like pigments, accelerators and PCMs) on a local basis.

#### Other materials

Textiles with variable layering properties make it possible to create graduations in permeability (Diagram 4) and in the stiffness of the material. For example, moisture transfer processes could be defined differently on a local basis within a continuous building shell, as is already state of the art in connection with functional cladding. The variation in stiffness properties makes it possible to overcome the distinction between stiff and flexible components prevailing in the trade hitherto, which could provide the basis for completely novel architectural solutions in future.



Top: glass fibre texture with silicon elements for graduated permeability

Bottom: testing watertightness on the basis of stress caused by a defined water column, source: ILEK



With the help of a graduated process it proved possible to produce open-celled foam elements with variable porosity patterns. With infiltration as a second step, these foams can then be further processed to make components with varying distribution of stiffness properties to meet the requirements of the given case.



Graduated infiltration of reticulated polyurethane foam with glue cement in the interest of varying stiffness, source: ILEK

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Another aspect of the technology involving graduated materials is the objective of bringing together different materials in a flowing and seamless transition (see Diagram 6). This represents a new approach in joining technology above all, even if it means that varying thermal extension can no longer be defined so precisely at local level in view of the continuous transition involved, or load transmission avoided at specific locations. Under the auspices of the project, initial investigations are being carried out in relation to construction-relevant classes of materials, potential areas of application and possible production methods.



Vision: flowing material transitions (wood to aluminium), Photomontage, source: ILEK

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### Conclusion

The idea of the functional graduation of materials contains considerable potential for material savings, unexploited hitherto, as well as for the more economical use of resources. In addition, the improved properties of the materials in terms of building physics and bearing structure can make a further contribution to the saving of energy and materials [3]. In the field of joining technology, flowing material transitions make it possible to avoid the weak points that have existed in the past.

On the other hand new design possibilities also result, as the component design no longer has to be subject to the logic of homogenous materials and their homogenous properties. Whereas in the past the principal focus of optimisation was on the idea of formal design in keeping with the materials, this research project offers an opening for the new concept of choice of materials in keeping with the form [4]. This represents an important stimulus for German building culture to meet the major ecological challenges of our time and so add to its already high international reputation. ■

<b>Short title:</b>	<b>Graduated building materials in the construction industry</b>
Applicant/research body:	Institut für Leichtbau Entwerfen und Konstruieren (ILEK) [Institute for Lightweight Structures and Conceptual Design] University of Stuttgart Pascal Heinz Dipl.-Ing., Michael Herrmann Dipl.-Ing.
Total cost:	€ 164,000
Government subsidy:	€ 109,500
Project duration:	01.05.2009 – 31.12.2010

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# Predictive operating procedures

## Improving energy-efficiency and comfort in building operating systems through the use of predictive operating procedures

The use of weather forecasts makes it possible to optimise the running of modern office buildings in relation to user comfort and energy requirements. The object of the project is to develop mathematically based optimisation procedures to be used in connection with automated building utilities. Another object of the research project is the development of an internet-dependent power supply based on weather forecasts transmitted by long-wave broadcasting.

### Object of the research project

In view of the need to reduce CO<sub>2</sub> emissions, coupled with rising energy prices, the properties of buildings are coming to play an increasingly important role. The enormous energy savings potential in this sector becomes plain when we contemplate the fact that the buildings sector is responsible for around 40% of the total energy consumed in Germany. In the field of technical building utilities recent years have seen the development of many new possibilities of power supply and distribution. Typical examples are technologies for the use of geothermics to obtain heat and cold, or new energy distribution systems like thermally active building systems (TABS), whereby large-scale building components like intermediate flooring can be cooled or heated by internal water conduits (see Diagram 1).

Experience shows, however, that it is not possible to exploit the considerable cost savings in this sector, in view of the fact that the methods and algorithms of automation technology have not been able to keep up with the complex supply systems of modern buildings.

At Hochschule Offenburg [Offenburg University of Applied Sciences], the Sustainable Energy Technology research group has developed new methods for the optimisation of operating procedures in large non-residential buildings [1]. The integration of expert systems with the automated building utilities provides the basis for the optimised and predictive operation of the building systems, based on evaluation of weather forecasts and the use of dynamic building system simulation. It has already proved possible to develop and market the first applications of this class, and some are already permanently installed in the utility systems of existing buildings.



Cementing an intermediate floor with pipelines (red) for building component activation,  
Photo: Hochschule Offenburg

The aim of this project is to identify and describe further possible areas of use. Based on this, it is hoped that new predictive algorithms and mathematical optimisation procedures for building automation will be developed, with a view to optimising the building operating systems through the use of forecasts of weather patterns and adapting the use of the building in the interest of energy-efficiency, comfort and sustainability.

A problem by which buildings are frequently affected is the lack of any way of optimising the control systems when the building is commissioned or when the building's use is changed. The expense that would be incurred by resorting to the costly services of experts, with the likelihood of having to take extended readings over a long period, seems unjustifiable. In most cases, however, the building operator remains unaware of this lack. The building functions in a satisfactory manner, and the excessive energy budget either goes unnoticed or is just accepted as unavoidable.



Short title:	<b>Predictive operating procedures</b>
Applicant/responsible for processing:	Hochschule Offenburg, Professor Elmar Bollin Dipl.-Ing., Thomas Feldmann Dipl.-Ing.
Project partner:	Hochschule Köln [Cologne University of Applied Sciences], Professor Wolfgang Schellong- HKW-Elektronik GmbH, 99846 Seebach S. von Keitz Gebäudeautomation, 06773 Gräfenhainichen
Total cost:	€ 217,500
Government subsidy:	€ 143,682
Project duration:	01.10.2009 to 30.06.2011

Significant improvements could be achieved here with the help of smart, self-optimising algorithms that are capable of learning. Two different approaches have been followed in connection with this project. Optimisation procedures on the basis of non-linear regression models and rule-based Fuzzy Systems in conjunction with artificial neuronal networks have been developed and tested using simulation models [2].

Weather forecasts in the past have been transmitted to automated building utilities either by ftp download or by web service. But in safety-critical areas the connection to the internet that is needed for this is often impossible, or else is seen as being undesirable. This research project therefore set out to develop new methods of reception. The basis for this was the already existing possibility of sending weather forecast data embedded in the transmission protocol of the DCF77 time signal broadcast (Diagram 2). These data are being used in applications of the consumer goods industry, for example in home weather stations or radio alarm clocks that not only wake you but give you a weather report as well.

For the new procedure a broadcasting network has been used with a higher transmission rate, making it possible for more information to be conveyed. The reception technology can be incorporated in radio clock receivers, economically and in compact form. Weather forecasts based on weather models necessarily have a finite resolution. With very good weather models you can get resolutions of around 10 kilometres. But at the same time, temperatures within a city may vary by as much as 5 degrees, depending on the location. This calls for the adaptation of the model forecast to the values actually registered at the location of the building. The recep-



DCF77 time signal broadcasting unit in Mainflingen,  
Photo: Hochschule Offenburg

tion module will therefore optimise the forecast it receives for the building location, with the help of locally registered climatic data.

### Conclusion

A far-ranging study on the state of development of predictive methods in building automation has been carried out. The regression models and neuronal Fuzzy Systems are still being developed. These will be programmed in the Matlab/Simulink programming environment and can then be linked in directly with the TRNSYS building simulation system.

For the reception of the weather forecasts, various reception modules have been developed and wide-ranging investigations carried out in relation to suitable antenna and filter configurations. In consultation with meteorologists, several correction algorithms for the localised optimisation of the forecasts have been investigated. A start has been made with the implementation of the system on a suitable microcontroller platform. ■

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# The construction materials market of the future: hi-tech products instead of bulk construction materials?

Tanja Brockmann D.Eng., Head of Department at BBSR

Tanja Brockmann D.Eng. was a scientific advisor at the Institut für Bauforschung [Institute of Building Research] of RWTH Aachen, then she worked for Deutsche Beton- und Bautechnik Verein e.V. (DBV) [German Concrete and Building Technology Association] and is now Head of Department II 6 (Building Materials and Building Design in Construction Engineering) of the Federal Institute for Research on Building, Urban Affairs and Spatial Development within the Federal Office for Building and Regional Planning.

**New materials in the construction industry – what do we have to look forward to?**

Existing materials are still going to be around – we will continue to work in future with concrete, steel, glass and wood. But within these material groups changes are taking place. Mostly it is a matter of relatively small tweaks that nonetheless make a big impact. People are trying, on the one hand, to improve the effectiveness of various construction materials, so that in the end result we may be able to make ultra-strong and streamlined building components. A further trend is the development of highly specialised building materials and building products – like self-cleaning façade elements or switchable glass façades, for instance, or ultra-efficient façade insulation systems. Take interior plastering as an example. If you just add a phase change material like paraffin, a building material that was used originally to cover the walls becomes an element for the systematic control of room temperature. The stimulus for the development of this kind of hi-tech construction material comes in part from the demands of energy efficiency, climate-friendly building and reduced greenhouse gas emissions. But the materials in question are often composite building materials with complex layered structures, which do not meet the recycling and degradability requirements of today.

**How is the specialisation of construction materials likely to affect building planning?**

As the developments I mentioned are still only in the initial stage and are not yet widely in use on the market, these hi-tech construction materials aren't going to be a significant factor in planning in the near future. But a possible future scenario could be that these specialised construction materials make it possible to develop building components with a wide range of additional properties. Partition walls would then not just serve to separate rooms but would also have an effect on the spatial acoustics and room temperature or purify the atmosphere with the help of photocatalytic additives. Coming generations of planners may be able to work with multifunctional building components which would be developed for specific uses in connection with the given project.

**The variety of materials on building sites is already practically unmanageable. Whereas the automotive industry has signed an agreement committing itself to an obligation to accept returned goods, with the consequence that only half of the spectrum of materials actually gets to be used in today's cars, we don't see any material limits in the construction industry, or any obligation on the part of manufacturers to accept returns.**

The construction materials industry will have to make arrangements for the return of goods – in Germany we are having to cope with an estimated 50 million tons of building waste every year. But little of this waste gets recycled in a meaningful way – 5% at most. This needs to improve in future. Actually all manufacturers should offer a practical recycling strategy for their products. Fixed compound materials are a par-





ticular problem, as you can't sort the demolition materials as effectively as you could wish. And their material composition is often a complete mystery, which of course makes it a difficult business. As a result, demolition materials can only be used to make a new product of inferior quality. This takes us into downcycling – a real recovery of the original materials in the manufacturing process to yield building materials of equal quality is hardly happening at all today.

**What approaches are available for the effective recycling of building waste?**

In the automotive industry recycling has reached a very good level. By contrast with construction, it is a whole lot cheaper to create the conditions for recycling. The materials used are easier to recycle – metals, for example. But above all automotive manufacture we find designs that permit reconversion. Individual components can be detached and deliberately reused in a different context. Extending this to the building trade, it would mean the use of detachable connections. But detachable connections are often seen as being a weak point. Besides, we need to remember that in the construction industry speed and cost are crucial. Adhesive connections smooth out inaccuracies – gluey materials make up for the cowboy building that results from time and cost pressures. But the use of building foam shows that we should have been working to higher standards in this area. An improved quality of execution – or building quality, for that matter – forms a better basis for the subsequent recycling of demolition materials.

A further possibility for simplifying the use of materials resulting from demolition in an intelligently conceived recycling chain would be systematically designed waste depots. But however favourable we may make the starting conditions for handling building waste – the idea of the recycling-based economy has not still not yet established itself in the construction industry. This is the area where we will have a lot to do in future.

**One last question – What kind of house do you live in? Is it all you could wish for?**

(laughs) I'm very fond of my home. I live in a wonderful old building with a stucco ceiling, ornamental door fittings and wooden floors. The beauty of the place where I live is important to me – more important than the functionality. ■

## Ensuring the future capability of buildings and building facilities

Professor Thomas Lützkendorf of the University of Karlsruhe (TH)  
on the economics and ecology of residential building

As an integral part of our national sustainability strategy and as a contribution to the European Union's Sustainable Construction Lead Market Initiative, research resources are being dedicated to the encouragement and support of the continuing penetration of the principles of sustainable development in the fields of planning, construction and building operation. A major area of emphasis for research concerns the connections between sustainability on the one hand and building quality and building culture on the other. Methods of sustainability assessment that have been developed and evaluated can also serve for the scrutiny of the economic, ecological and social advantages of solutions that are being developed in other areas of research. So we are dealing here with a matter having cross-sectional implications.

Projects resulting from commissioned and subsidised research are currently supplementing and extending the fundamental principles that will make it possible for the contribution of individual building structures to sustainable development to be described and evaluated. This relates not only to methods (including external costs and the analysis of user satisfaction) but also to data fundamentals (e.g. the service life of building components, ecobalance data for domestic technology, lifecycle costs, data on the separability of material layers and information systems for building products), evaluation criteria (including those for judging resistance to the consequences of climatic change, assessment of fine dust emissions, interior hygiene etc.) and the elaboration and testing of system variants for the Bewertungssystem Nachhaltiges Bauen – BNB [Sustainable Construction Evaluation System], including for existing office buildings, residential housing, educational buildings and outdoor facilities. The essential findings will be summarised in the Leitfaden Nachhaltiges Bauen [Sustainable Building Guidelines], which deal both with new building and conversion projects. This document will be made accessible to the general public at the [www.nachhaltigesbauen.de](http://www.nachhaltigesbauen.de) website. Under the

auspices of subsequent research the Sustainable Construction Evaluation System will be applied to further pilot construction projects, evaluated and compared with other systems. The experience acquired will go to the development and testing of programmes for the training and further training of decision-makers, planners and auditors.

In addition to the direct evaluation of sustainability, research projects will also support the integration of sustainability aspects with relevant methods and procedures. This relates not only to the fundamentals of climate-adapted building, the planning and realisation processes of industrial buildings, focus on the lifecycle in invitations to tender and the award of contracts, the concept of strategic building components and valuation methods and risk analysis but also to the provision of suitable building data and product information and creating the fundamentals for lifecycle-related property management.

A major emphasis of research under the Zukunft Bau scheme is on supporting the development of joint positions for sustainable building in Germany and seeing that these are actively represented on international bodies. This extends from scientific consultancy to the Sustainable Building round table to the active support of work on international and European standards, as well as contributions to the Lead Market Initiative and the presentation of working results international conferences (EXPO 2010, Sustainable Building 2011 and others). To encourage the further improvement of building quality, taking sustainability aspects into consideration, innovative approaches are being developed and tested in relation to building products and technology. The objective is to optimise the service life and durability of building components, windows for instance. At the same time it is a matter of quality assurance issues in connection with products, processes and planning tasks, e.g. the computer-based planning of bearing structures. This is another area where contributions are being made to the sustainability of buildings. ■

# LED lighting in offices, taking the Federal Audit Office project as an example

Kurt Speelmanns

BBSR Department II 3 – Research in the Building Industry, Technical Buildings Management

Department II 3 of the BBSR is not just the business office of the Zukunft Bau research initiative, it is also a pioneer in the encouragement of new technologies on the path to practical application. One of the projects it supported in this connection was the conversion of the office lighting at the Federal Audit Office in Bonn to exclusive reliance on LED illumination. There follows a report on the experience resulting from the realisation of this project and on the insights acquired thereby in relation to current research needs.

It had already been decided in the initial planning phase of this project that the existing ceiling lighting should be decommissioned. Instead a standing luminaire was to be used, supplying direct light to the workplace and indirect light to the rest of the twenty metre square room. In comparison with the conventional solution, the idea of workplace-related lighting provided by a standing luminaire already promised considerable energy savings. Further economies of consumption were to be realised with the help of integrated brightness controls and presence sensors.

After a prototype model had demonstrated the feasibility of this project, an invitation to tender was issued and the contract awarded in the context of a pan-European competition. The best offer came from the Osram/Trilux bidding consortium. The efficiency of the LEDs used comes to around 125 lm/W – a value which can be improved on in relatively short cycles, in view of the extreme rapidity of further developments in this field.

A main focus of the work was on adherence to the occupational health and safety regulations. In view of the fact that the standing luminaire to be installed was intended to be the only source of light in the offices, requirements relating to health and safety in the workplace were a particularly important consideration.

The outcome of all this was the requirement that illumination with a strength of 175 Lux must be provided for the periphery of the room. This in turn had the result that the proportion of indirect lighting in relation to direct light came to a very high figure (a ratio of 85 to 15 percent).

In practice the realisation of this requirement sets limits to the reduction of energy consumption, as a result of the greater potential for waste and increased investment costs, seeing that this performance feature is only attainable when the luminaire is equipped with high-standard light emitters. With the luminaire that was finally chosen this resulted in a system output of 130 watts, which however would only be needed when the light is used to full capacity. In practical operation this situation is hardly likely to arise, so the question arises whether it is really necessary to procure a luminaire with an output that will only be needed to the full extent for a few hours in the year.

It further emerged that the research results that gave rise to the minimum requirements for workstations and other lighting situations (e.g. 500 lx for office workstations) are actually outmoded, as they were based on investigation of the lighting facilities available at the time and involving young and healthy people. In view of the findings of this project (there are indications that top-quality LED lighting can provide sufficient light for reading and colour rendering even at illumination levels below current lighting standards), it has been established that new studies for the measurement of lighting strength are called for.

In this connection we need to make distinctions based on the type and light colour of the lighting fixture, and the mixture of natural and artificial light in connection with automated and manual brightness controls and the effects of demographic change also need to be taken into account. Here research into the fundamentals is called for, and research institutions that are suit-



ably equipped are urged to devote their efforts to the investigation of these issues.

Particular attention was also dedicated to the light temperature of the light emitters. In deviation from the frequently prevailing requirement that the light should have a warm colour, this project fixed on a light colour of 6400 K. Crucial factors here, with implications for other projects as well, are the improved colour rendering, the lack of colour distortion with an admixture of natural light in connection with automated brightness controls, the reduced strain on the eyes when reading and the associated positive effects on health.

Unfortunately the good properties of the higher colour temperature have not met with universal acceptance. Comments like 'too blue', 'too white', 'too cold' and 'a masculine light' have been heard. Many people have also argued that the higher colour temperature makes them look 'ill' and shows them to disadvantage. In this area there is a considerable need of clarification, and perhaps further research work needs to be done. It would be a pity if prejudice against the higher light colour should make it impossible to benefit from the significantly improved effects on health in the workplace this setup promises as compared with conventional lighting scenarios.

In the presentation of results from the invitation to tender, the conclusion was reached that

artificial light requirements in the illumination of workstations vary widely from one building to another. Significant factors here are the size of the windows and the design of the façade with reference to the window recesses, and the colour decor of the surrounding areas and furnishings also need to be considered. This means that in situations which are less favourable for the use of natural light more energy needs to be consumed for artificial lighting. On the one hand this affects the output that will be required to provide adequate illumination. On the other, we can also expect that in an unfavourable situation of this kind there will be more hours of use than in a more favourable scenario.

In view of the fact that both aspects are subject to multiplication, even a slightly worse building situation is going to have considerable implications for the annual artificial lighting budget. This means that more attention needs to be dedicated in future, in ongoing research on the regulations and requirements of this field, to this aspect of limiting energy consumption and reducing CO<sub>2</sub> emissions. ■

Photo: Trilux GmbH und Co KG



# Innovations in the construction industry

Stefan Rein

BBSR Department II 4 – Building, Construction Industry, GAEB

[Gemeinsamer Ausschuss Elektronik im Bauwesen/Joint Committee on Electronics in Building]

The Zukunft Bau research initiative has subsidised a project with the title 'Innovation Biographies in the Construction Industry'. This was aimed at the investigation of the introduction and spread of innovations in the German building trade. The study has shown that the pattern of innovations in the German construction industry is significantly different from that of other industrial sectors. Innovations in building are generally introduced with a view to optimising internal processes and procedures and cutting costs, and frequently relate to a distinct problem that needs to be resolved in the short term. This does however detract from their visibility, and means – by contrast with pure product innovations – that they are only rarely noticed by the customer and fail to raise the image of the industry. Product innovations essentially occur in the sphere of the building trade suppliers (manufacturers of construction materials and building products, and the construction machine industry), whereas construction companies on the whole focus on the development of procedural innovations. The tasks of planners and commercial builders, as significant technology users in the areas of construction machinery, construction materials and technical building services, are particularly concerned with the implementation of innovative solutions on the practical level. Planning and building processes need to be coordinated in the best possible way to take advantage of innovations. New products should be tried out on the market, and feedback given in relation to any problems and possible optimisations. Planners and the building trade thus have a decisive part to play in the dissemination of innovative products.

So a central conclusion of the study was that the entire value creation chain needs to be taken into account, if we are to be able to form a correct judgment of the innovative potential of the

building sector. In March 2009, for the first time in its history the German building industry came to an understanding about a shared guiding ideal for the value creation chain as a whole. This also takes account of the thematic importance of innovation: 'The innovative strength of the value creation chain that is the building industry should be reinforced. Germany should become a leading market for innovative construction.'

A supplementary research project entitled 'Innovation Strategies in Building – an International Comparison' proceeded to compare innovative activity in different European countries. The surprising result that emerged was that Germany has a clearly leading position in terms of registered patents in the building sector. Nearly 42% of all patents in the EU 15 countries considered come from Germany, with one-off discoveries dominating the picture. The data comparison moreover showed that Germany – with reference to the building value creation chain – has a more than average share of industrial suppliers as well as architects. This is characteristic of the specialisation process in the building industry, while at the same time the German building trade is notable for its disproportionately great manufacturing depth.

There remain challenges, it must be said, in connection with the dissemination of innovations. Experience derived from other countries, and/or new forms of communication (like the Innovation Cafés in Switzerland) may be helpful in this connection. Benchmark systems of the kind used in Denmark and Great Britain can lead to improved market transparency and to the optimisation of processes in building companies. Finally the study points to the urgent need of improved further training measures, with a view to enabling trade professionals to make the best use of available knowledge within the building value creation chain. ■

# Innovation Strategies in Building – an International Comparison

Stefan Rein

BBSR Referat II 4 – Bauwesen, Construction industry, GAEB

## EPO patent registrations 2000-2007 in the Building technology sector

	In absolute terms	Share of building patent registrations of the 15 countries in %	Total share of EPO building patent registrations in %	Patent registrations per 100,000 persons in gainful employment	Patent registrations per 1000 employees in the building value creation chain	RPA
Belgium	654	3.6%	2.0%	13.7	1.8	51.0
Denmark	452	2.5%	1.4%	15.3	1.7	44.7
Germany	7,707	42.0%	24.0%	18.3	3.1	18.5
Finland	316	1.7%	1.0%	11.7	1.6	-34.4
France	2,470	13.5%	7.7%	8.8	1.2	10.1
Great Britain	1,592	8.7%	5.0%	5.1	0.8	14.7
Italy	1,600	8.7%	5.0%	6.4	0.6	30.9
Netherlands	1,248	6.8%	3.9%	14.1	1.9	1.2
Austria	953	5.2%	3.0%	22.4	2.5	76.7
Poland	48	0.3%	0.1%	0.3	0.0	67.7
Portugal	50	0.3%	0.2%	0.9	0.1	82.8
Romania	28	0.2%	0.1%	0.3	0.0	97.9
Sweden	666	3.6%	2.1%	13.6	1.8	-7.2
Spain	535	2.9%	1.7%	2.3	0.2	61.1
Hungary	36	0.2%	0.1%	0.9	0.1	29.4
EU-15	18,355	100.0%	57.2%	8.4	1.1	
Switzerland	1,292			30.2		14.9
Other countries	12,426					
<b>Total of all countries</b>	<b>32,073</b>					

Source: European Patent Office (EPO) – Espace Bulletin database;  
computations of the IAT – Institut für Arbeit und Technik [Institute of Labour and Technology],  
Gelsenkirchen (Nordhause-Janz, Dr Rehfeld, Welschhoff)  
Project duration: 01.07.2009 – 24.10.2010.

# The Zukunft Bau research initiative: facts and figures

Miriam Hohfeld

BBSR Department II 3 – Research in the Building Industry, Technical Buildings Management

The Zukunft Bau research initiative stands for an impulse in the direction of greater innovative strength in building, based on greater commitment to research and development. Zukunft Bau consists of two programmatic sectors – subsidised research (Antragsforschung) and commissioned research (Auftragsforschung) – which in turn are subdivided into thematic groups or ‘research clusters’. Now that the first five years of the programme have been successfully concluded, it is worth taking a look at the facts and figures of what has been achieved in the period from 2006 to 2010.

## **Commissioned Research (research and investigative studies in the building sector)**

With a budget amounting to around 15 million euros, in the years since 2006 some 175 research commissions (averaging 35 per year) have been awarded on the following themes:

- Energy efficiency, climate protection
- Regulatory codes for building products
- Art in building
- Construction industry
- Building quality, sustainability

Current areas of emphasis include supportive research projects for drawing out the implications of statutory regulations (like the Energy Saving Directive, for instance), projects for the support and observation of European and international activities (like the extrapolation of the Building Products Guideline or the comparative examination of compliance activities in neighbouring countries) and projects for the further development of sustainable building or relating to other top-level themes connected with the government’s building activities.

Particularly worthy of emphasis are developments in the area of plus energy houses, which impressively underline Germany’s leading position in relation to futuristic technology in the buildings sector.

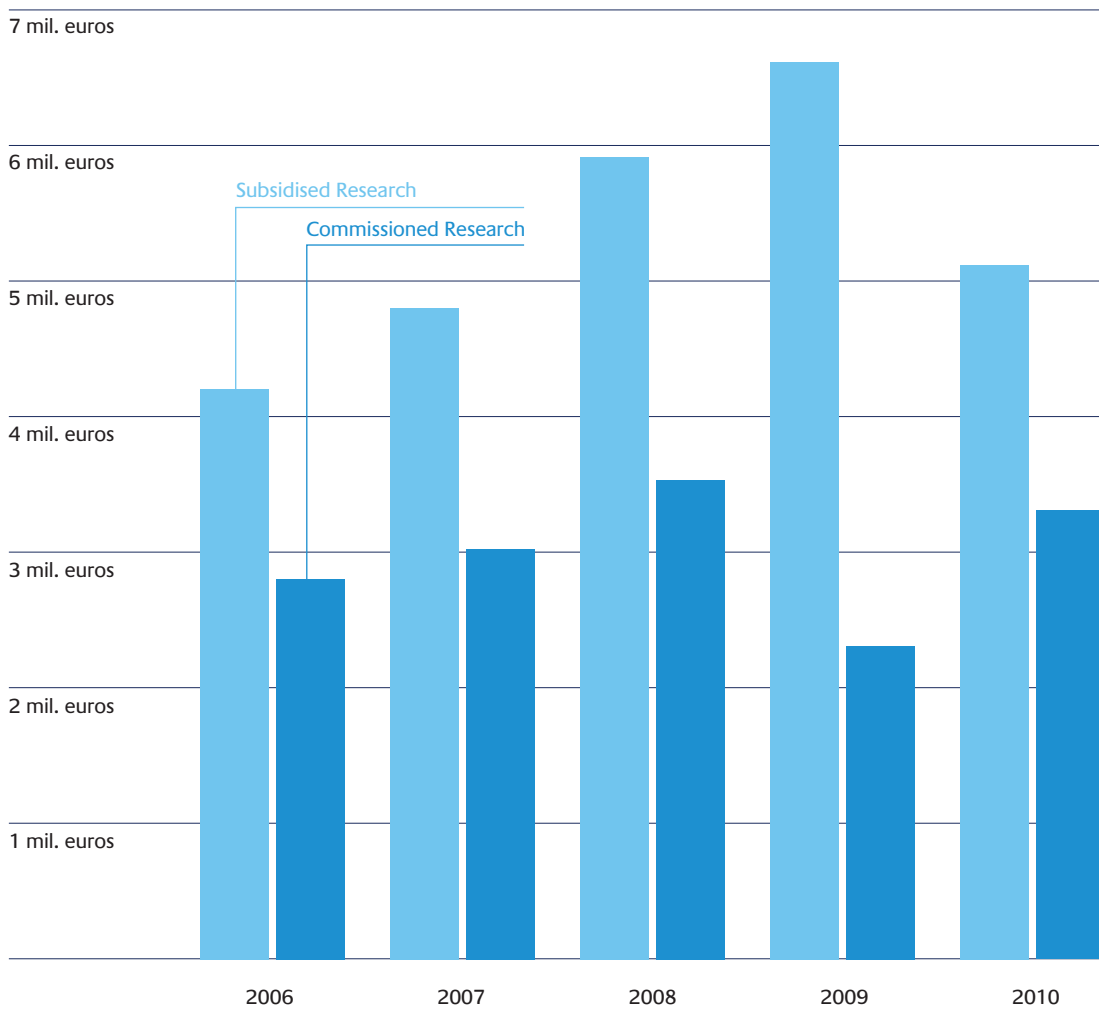
## **Subsidised Research (subsidies for research in the field of construction)**

With a budget amounting to around 27 million euros, in the years since 2006 some 200 research projects (averaging 40 per year) with a total volume of 40 million euros have been subsidised on the following themes:

- Energy efficiency and renewable energy in the buildings sector, computation tools
- New concepts and prototypes for energy-saving building, zero and/or plus energy house concepts
- New materials and techniques
- Sustainable building, building quality
- Demographic changes
- Regulations for the award of construction contracts
- RFID techniques in the building industry

This makes applied building research a crucially important component on the path to the widespread use of the most up-to-date technology in the building industry. The common feature is the processing of complex thematic areas and research subjects in a cross-disciplinary network of scientific institutions with the building industry. In the area of subsidised research alone, since 2006 more than 1200 research applications have been submitted. In view of the continuing demand and the high quality of the project results achieved, BMVBS has again made considerable additions to its forthcoming programme in both sectors from 2010 onwards. ■

Distribution of budget resources from 2006 to 2010





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[www.forschungsinitiative.de](http://www.forschungsinitiative.de)

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