

SOLARCAMPUS – PROJECT-BASED STUDENT COURSES TURN A UNIVERSITY TOWARDS RENEWABLES AND ENERGY EFFICIENCY

K. Vajen, P. Emmerich, C. Rose, A. Maas*, S. Schlitzberger*

Kassel University (Germany), Institute of Thermal Engineering, solar@uni-kassel.de

* Kassel University (Germany), Department of Architecture, Urban Planning and Landscape Architecture, maas@asl.uni-kassel.de

Abstract

In some countries, e.g. the USA, project-based student courses are an important part of the curricula, sometimes they even belong to the required lectures. The main objective of these courses is to put students into typical and also realistic situations and processes, which are similar to those appearing in graduates' future work and which can't be taught in the context of lectures and seminars. In course of the changeover to a consecutive education system in Europe with bachelor and master programmes these kind of practical orientated courses become increasingly important.

The project-based student course “*solarcampus*” was started at Kassel University in the winter term 2005. It is complementing the master programme “Renewable Energies and Energy Efficiency”, but is also open for other degree programmes. Thus, students of many programmes have the opportunity to practice their specific knowledge learned in lectures. Furthermore, they can integrate the course into their individual course scheme with credits and grades.

Beside the students, also the university takes advantage of the course's activities, because contents of the course aim at the implementation of sustainable projects in the field of renewable energies and energy efficiency at the university itself. For example, students in the first project phase executed the realization of photovoltaic systems on the university's roofs. In the second project phase they develop concepts to improve systems engineering and thermal insulation of the university's buildings.

This paper describes the main didactic concepts of the course, combining practical work, teaching and science. Furthermore, the main contents of the course are shown.

1. INTRODUCTION

As the budget of many universities all over the world, that of Kassel University suffers by increasing energy costs. On the other hand, highly motivated students in the master programme Renewable Energies and Energy Efficiency in Kassel want to extend their practical experience. How to create a synergy?

Two professors launched the interdisciplinary project-based student course *solarcampus* in winter term 2005. In the first phase, photovoltaic systems with a total power of 67 kW_p were installed on roofs of different buildings of the university. The choice of appropriate roofs, planning and marketing has been carried out completely by students, enrolled in different programmes. The investment of around 350,000 Euro was ensured with a unique private investor model without any cost for the university.

The second phase of the project started in 2007. The main goal is now to improve the energy efficiency of the university's buildings. Technical potentials of energy saving measures are determined by both, theoretical methods and measurements. Based on the results, energy saving measures in the building services and other technical equipment are developed. It is planned to implement again a private fund for investments in energy saving measures. So, the university's budget shall be even relieved of costs.

2. CONCEPT OF THE COURSE

In summer term 2005, the master programme “Renewable Energies and Energy Efficiency” started at Kassel University. In the following term the project-based student course *solarcampus* was added to the course scheme. From the beginning, the basic idea was the implementation of a course which brings students of different programmes and disciplines together, that are somehow involved in renewable energies and energy efficiency projects. Contents arise of current issues in the direct surrounding of the university.

Main Objectives

The main objective of *solarcampus* is to give the participating students the opportunity to develop both, technical experience and soft skills for interdisciplinary teamwork in their future working life, as both is mandatory in the field of renewable energies and energy efficiency.

Therefore; long-term sustainable projects at Kassel University are accomplished. This contributes to the consolidation of the university’s environmental profile, without any investments of the university itself and even relieving its budget, respectively. Furthermore, among the students and academic members of staff the awareness is raised regarding renewable energies and rational energy use in their immediate work environment.

Contents of both project phases “photovoltaic” and “energy efficiency” are mostly different, but methods to obtain the objectives are very similar.

Integration in module scheme

Contents of *solarcampus* are mostly based on the lectures of the master programme Renewable Energies and Energy Efficiency. These include general energy-technical basics as well as special contexts of buildings and systems engineering. Since the projects are generally characterized by interdisciplinary problems, students of other disciplines like mechanical, electrical or civil engineering architecture, economy and, if necessary, law are asked to contribute to the project.

The course can be taken each term. At the beginning, students decide on their individual effort by themselves, depending on the number and kind of credits (technical and/or non-technical) they need. Finally, the course is added as elective to the course schemes.

Didactical Approach

Simplified, *solarcampus* operates like a firm of consultant engineers. Client of this “company” is the university. Purpose is to accomplish analysis and develop concepts to improve the energy performance of the client’s buildings.

Usually projects take several years, but students are able to participate only for one or two terms, if desired. Thus, in the beginning one general question was how to ensure continuity. Therefore a special project schedule was developed, as shown in figure 1 below.

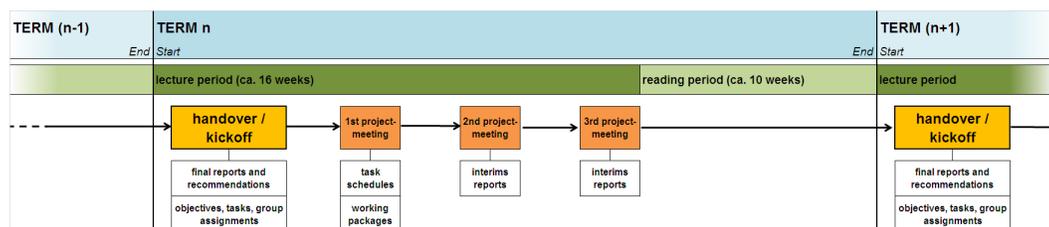


Figure 1: General project schedule

Based on the results and final reports of the last term, project and group leaders define new tasks, which shall be worked on in the coming term. In some cases working groups just continue the work of their forerunners. In other cases, it is required to create new working groups because new issues arose. Thus, working groups can be just temporally or even permanently.

Most important meeting in a term is the handover. Usually it takes place in the second week of the lecture period. It is both, final meeting for the students participating in the last term and kickoff meeting for new students. Main topics are on the one hand the different working groups' presentations of lessons learnt, results and recommendations for further investigations. On the other hand objectives, tasks are introduced and two to four parallel working groups are established with up to ten students each. In this way, continuity and knowledge transfer from one students' generation to the next is ensured. It is important that new tasks can be finished in one term and that they are clearly and easily understandable introduced to the newcomers, so that they get interested in taking part.

At the beginning of a term each participating student decides on his/her personal effort from one to six (in some cases up to 12) ECTS-credits (One ECTS-credit corresponds to 30 working hours of the students.). The distribution of the tasks to the group members is according to the individually defined amount of credits. The work done is proven by individual time sheets.

Project meetings take place periodically. In the single working groups the meetings are called about weekly, the meetings with the whole students group monthly. On these meetings working groups give interims reports of their activities. Results and problems are discussed with the whole group and especially the professors. Based on that, further steps are planned.

At the end of a term (about two weeks before handover) each working group submits its final report which was written in the reading period. Layout and structure of these reports are by default. Content and quality of these reports are one part of the final marks.

The evaluation of each student's performance is carried out in two steps. At first, each student reflects his/her own work and proposes a grade to the student group leader. If all students agree, they send a list with proposed individual marks for all students to the professors. So far, experiences with this kind of marking show that students evaluate their own contribution pretty objective.

Participants

Heads of *solarcampus* are Prof. Dr. Klaus Vajen (Department of Solar and Systems Engineering) and Prof. Dr. Anton Maas (Department of Building Physics). Single working groups are coordinated by two PhD-students and one scientific assistant. Especially for these, *solarcampus* offers the possibility to improve their social and leading skills beside the extension of their scientific specialization.

From the beginning, *solarcampus* has been supported by the university's executive board and administrative departments. At periodic meetings, objectives and proceeding are agreed on. Furthermore, students are supported on their specific issues by members of the facility management, who give access to certain rooms or assist with the implementation of measurement instruments. Measured data and results are even discussed with them. Without this support, the project could not take place in that way.

The technical department of the university can and shall influence the subjects worked on. So is ensured that the student's work deals with actual problems and will come to an implementation, if it has been carried out sufficiently careful. It is a significant share of the student's motivation that term papers of *solarcampus* shall never be done just for the files.

The number of participating students in the project has increased continuously, especially in the last terms (figure 2). On the one hand, the topic "energy efficiency" is very "up-to-date", so that students want to increase their professional prospects. On the other hand, the size of the group is according to the complex problems to be solved. That is also shown by the growing amount of different disciplines involved in the project. The success of the project is also underlined by another fact: Some students stay in the project, although it is not possible for them to get any more counting credits.

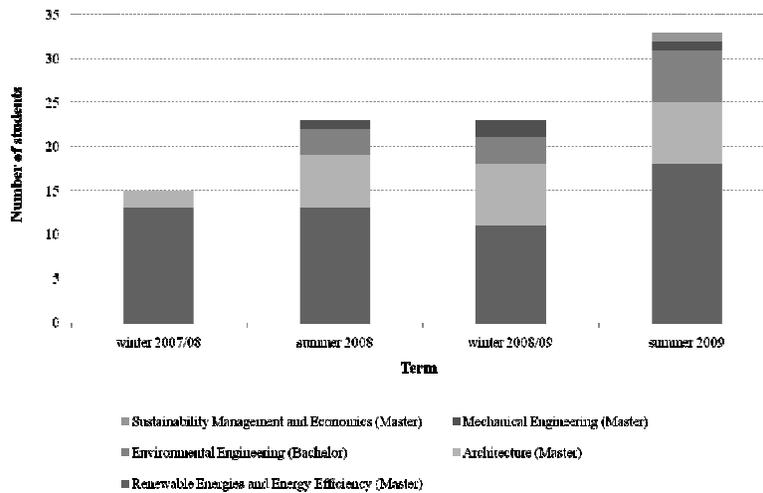


Figure 2: Number of students in the project „Energy efficiency at Kassel University“, differentiated by degree programmes and terms. The PV project attracted 2005-2007 in total about 50 students.

3. COURSE ACTIVITIES

The main topics and contents of the course can be separated in two main phases: The first phase took place from winter term 2005 to summer term 2007. Photovoltaic systems with a total power of 67 kW_p were installed on roofs of different buildings of Kassel University. In the current phase, running since winter term 2007, the main issue is to improve the energy performance of the university's buildings.

Photovoltaic project

Starting point of the project were the results of a diploma thesis: One main result was, that approximately 3,000 m² on different roofs of the university are principally suitable for the mounting of photovoltaic modules. The main objective of the project was to exploit these potentials partly.

In the two-year project time, overall about 50 students from the master programme Renewable Energies and Energy Efficiency, Ecological Agriculture, Economics, Law, Architecture and Graphical Design took part in the realization process. One part of the work was the determination of technical and economical feasibility. On the other hand an alternative financing model for the PV-modules had to be ensured, because there was no possibility to get any money from the budget of the university. Especially in the first two terms it was necessary to attract a lot of publicity to the project.

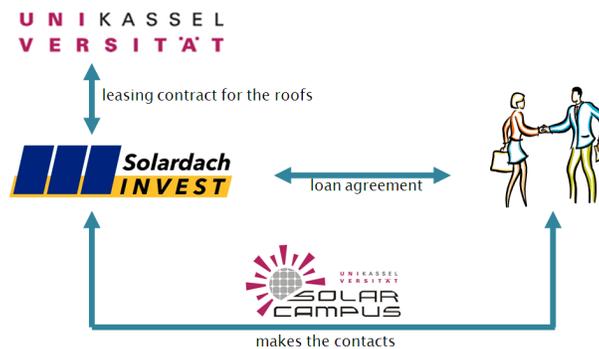


Figure 3: Contractual relationships and role of *solarcampus* during the photovoltaic-project

Finally, a financing model with public participation was chosen, which was – so far – unique in the higher education sector in Germany. More than 100 private investors, members of university's staff, inhabitants of Kassel and the surrounding region, granted loans of at least 500 Euro. *solarcampus* acted as intermediary. The students raised funds of about 350,000 Euro, which has been about 70% more than anticipated, and coordinated the contacts between investors, university and operating company. This company administrates the loans, erected and operates the PV system (figure 3). The students also worked out the necessary contracts.

Due to the oversubscription it was possible to put up three solar power systems instead of one with a power rating of 67 kW_p. With the guaranty of the feed in tariffs of the German "Renewable Energy Sources Act" loans are paid back during the next 20 years and investors get a pretty good rate of 4-6%, depending on the produced solar electricity.

Meanwhile *solarcampus-PV* has got a lot of successors at other German universities. It is one of the foundation members of the network "UniSolar", which wants to bring up and support such "solar initiatives" at German universities. Beyond that, *solarcampus* was awarded 2007 with a prize by EUROSOLAR.

Energy efficiency project

After the first project had been successfully completed, the second project was initiated in winter term 2007. Starting point were the energy bill of the university, which had increased by nearly 60% within the last five years. Furthermore the results of a master thesis and some preliminary investigations showed significant energy-saving potentials of at least 10% of current energy consumption.

Therefore, the following objectives for the next five years were agreed on with the technical department:

1. Identification and quantification of existing energy-saving potentials at Kassel University's buildings
2. Development of appropriate measures for reaching these savings
3. Development of financing models beyond the university's budget (e.g. fund model, similar to the one applied in the photovoltaic project)
4. Development of an energy monitoring and controlling system in the university administration
5. Development of a technical and organizational solution for encouraging energy-saving behavior of users

At the moment, the activities are focused on the systematic analysis of single buildings with high absolute and specific energy consumption, like two buildings of the Institute of Mechanical Engineering or the main canteen. Based on these investigations, specific measures are under development.

The focus of investigations in the main canteen lies on the hot water system. Students convinced the technical department to implement a solar thermal system with more than 100 m². Furthermore, they analyse the existing cooling systems and optimize its heat recovery. Most important for the two buildings of the engineering departments will be to realize a control of the central ventilation system which shall be adjusted to the actual needs. Besides that, students work out Energy Performance Certificates for several buildings, which are required by European law since July 2009.

Meanwhile students touch current state of research. So far there is no standard methodology, neither for a systematical determination of energy efficiency potentials of a university, nor for implementation of an energy-controlling. Models for public investments for energy savings are generally new and part of the current state of research.

Until now two master theses have been written in the context of *solarcampus*. Based on that two thematically and personally very closely connected PhD-theses have been started.

4. TRANSFERABILITY

The described courses could basically take place at any university all over the world. Whereas appropriate feed-in tariffs are mandatory for the financing and erection of a PV-plant, the improvement of the energy efficiency of the own university is a thankful task in each university. Prerequisites to carry out the course are

- a) the technical service of the university should clearly see its own interest and should support the initiative
- b) (at least some) students should have finished another course in building physics, technical service and/or solar energy
- c) the teachers should have good contacts to staff all over the university and beyond, because they have to advise the students especially regarding the administrative procedures and how to get access to measurement devices
- d) meetings with teacher and students should take place at least every second week
- e) not more than ten students should form a group, working on a specified subject
- f) the task for the upcoming term and the procedures regarding credits and marks should be clearly described

Interested university teachers can receive further information directly from the authors or from the website of the project (www.solarcampus.uni-kassel.de), which so far is unfortunately only available in German.

5. CONCLUSIONS

solarcampus combines highly topical practical issues with teaching and training of the students as well as the existing scientific expertise at Kassel University. This can benefit all involved parties: Students can apply their knowledge learned in lectures on concrete issues. The university gets support for its “environmental profile” and counteracts the increasing energy costs. The saved money can be used for its core functions: science and education. Last but not least: the reduced energy consumption contributes against climate change – a “win-win-win-situation” is created.

Success of the first phase is directly visible by the photovoltaic systems on the roofs of the university. In the ongoing second phase of *solarcampus* the results of the students’ investigations gave already essential knowledge of partly very high specific energy consumptions. In next steps, the origin of the highest energy consumptions shall be identified, the saving potentials shall be determined and the necessarily counteractive measures are to be taken.

The chosen form of practical orientated learning inside the “safe” surrounding of the university has been very successful. On one hand this is shown by the continuously increasing amount of participants – so far about 100 students have graduated the course. On the other hand some students keep on working in the project although it is not possible for them to get more marked credits.

solarcampus attracts students of different degree programmes with both the, new format of teaching and the topic “energy and energy efficiency at the university”. Thus, it encourages interdisciplinary cooperation in the context of complex problems. This project-based course is very flexible in its subjects as well as the different problems to work on, as in the organizational conditions, like individual time spent and procedure.

solarcampus was successfully implemented in the degree “Renewable Energies and Energy Efficiency” as a regular course. Furthermore, it is open for students from other thematically appropriate programmes, too. This kind of project-based student courses does not require special resources and is also transferable to other universities. The gained experience could lead other universities to launch similar courses. It is anticipated that cooperation with international university students will follow..

6. ACKNOWLEDGMENTS

The authors gratefully acknowledge the support provided by K. Sausmikat, A. Hellrung and M. Hohmann from the technical service of Kassel University.