UNDERSTANDING SOLAR THERMAL ENERGY CONVERSION

Jeanette Kristin Weichler[1], Korbinian Kramer[1] and Sumukha Dhathri[1]

[1] Fraunhofer Institute for Solar Energy System ISE, Freiburg (Germany)

Abstract

Internationally accessible "Understanding Solar Thermal Energy Conversion" course is designed to provide technical knowledge to interested parties with easy access. Transferring lessons learned and experiences acquired from mature markets to evolving markets, especially building up knowledge capacity about basics of technology is a way to speed up the qualified market penetration of solar thermal technologies in evolving markets. With this as motivation an online course was developed. The content structure of the course follows modern didactic, uses target group fitted new media and offers information on heat supply technologies as well as its non-technical aspects like social, economics and aesthetics. The course is certified by a German university and a German research organization based on certification model of Swissuni, and therefore can be easily counted towards thematically suitable university programs. The paper presents the innovative didactic approach of problem based learning as well as application-related, competence-oriented teaching, and describes the holistic contextual design of the course.

Keywords: Solar thermal; continuing education; SBLiC; e-learning

1. Introduction

Increased shortage of skilled employees in the Science, Technology, Engineering and Mathematics (STEM) disciplines, especially in the area of highly topical subject like energy storage, intelligent energy networks, solar thermal energy conversion technology and other energy fields, is the main motivation behind development of the renewable energy continued education program. The certified course "Understanding Solar Thermal Energy Conversion" is offered under this continued education program on current technologies. The focus of the course ranges from heat generation and supply, solar thermal technology and system variants to technical characterization and production processes, including simulation methods and the integration of solar thermal energy into architecture. The teaching is based on current results from applied energy research carried out at bachelor level of university course programs.

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2. Course Structure and Didactic Methods

The course content is taught in online learning format with a large share of online supervision. The learning material is provided electronically with several modern methods. The concept of e-learning enables world-wide access to high level knowledge at the spot building capacity. During studying, the participants are supported and accompanied in their learning process by didactically experienced lecturers who are experts on solar thermal energy.

On one hand such an implementation of the continuing education program aims to reconcile work, family and further education. On the other hand, this concept aims to provide participants increased flexibility in the individual learning process. In addition, the participants can choose which type of graduation they need. The course covers a mandatory part leading to a certificate of attendance and an optional CAS examination and certification part leading to a “Certificate of Advanced Studies, CAS” with 10 credit points (10 credit points correspond to 10 ECTS).

The mandatory part lasts 6 months, is completely available online, and combines self-study phases, regular online meetings and online supervision. The participants have to perform miscellaneous tasks such as small online tests, small written homework, two peer-feedbacks and finally a course evaluation. When all performance obligations have been met the participant receives the certificate of attendance from Fraunhofer ISE and Fraunhofer Academy.

The optional CAS examination part lasts five weeks. The first four weeks are an online preparation phase for examination preparation. The CAS-exam in written form can be taken in the home country of the participant or in Germany at the Fraunhofer Institute ISE, Freiburg.

The course is mainly designed for STEM professionals interested in increasing their knowledge of solar thermal systems. A bachelor degree or similar qualification in a STEM-field (for example a 'Meisterbrief' = master craftsman certificate) is required to participate in the course. The training targets the following groups:

- *Technicians, engineers, specialists and executives from energy sector*
- *Energy system and power plant optimizers*
- *Planners, consultants, project developers*
- *Political, technical, financial and economic decision-makers*

The following image (Fig.1) shows the course structure.

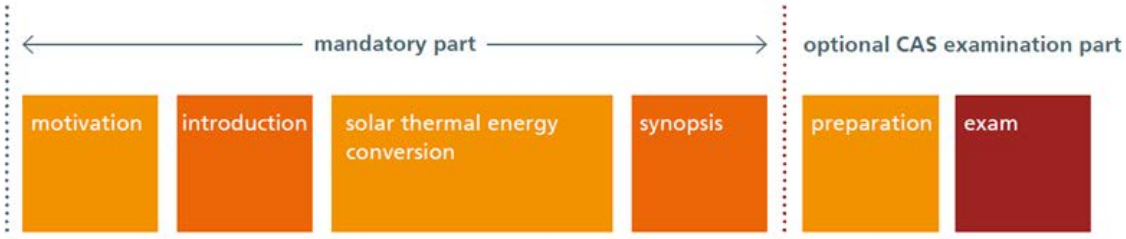

Fig. 1: Course structure of the CAS-module “Understanding Solar Thermal Energy Conversion”

The course itself is didactically structured. The units in the course are prepared using the method of scenario-based learning in cycles SBLiC (Weichler et al. 2015a and Weichler et al. 2015b). This method is based on problem based learning methods. It ensures that the knowledge transfer is practical, application-oriented and supports long-lasting, sustainable knowledge building. SBLiC has been developed especially for this part-time further education CAS course. The graphic in figure 3 describes the didactic method.

At the beginning of each lecture unit of the course, a realistic scenario is provided which motivates the teaching content of this lecture by using case examples, frequently occurring case questions or problems. In addition the scenario activates previous knowledge. Throughout all parts of the course, within the realistic scenarios or lecture units, the participants are accompanied by the cat ‘Bastet’ (Fig.2).

In the second step, the participants work with up-to-date and detailed training material. At the end of each lecture unit, students are encouraged to take provided self-tests and complete small exercises related to the studied unit to assess knowledge gained and to motivate further thinking.

At the end of each lecture unit the realistic scenario will be discussed and the whole group will develop solutions for the case example.

In addition, web-based online meetings take place every four weeks together with the lecturers. In these meetings the participants have the possibility to ask further questions, exchange their opinions on different scenarios or discuss realistic case examples. The meetings are recorded to compensate for time shifts if needed.

Fig. 2: The cat 'Bastet' guides the participants through realistic scenarios and the lecture units.

In the optional CAS examination and certification part leading to a "Certificate of Advanced Studies CAS" the participants will undergo an exam preparation. In this phase additional online meetings, self-tests, online supervision and exercises which focusses on the exam requirements are offered. Finally the written CAS-certification exam on high professional level organized in partner institutions around the world completes the continuing education, and when successfully concluded, the CAS-certification and grades are awarded.

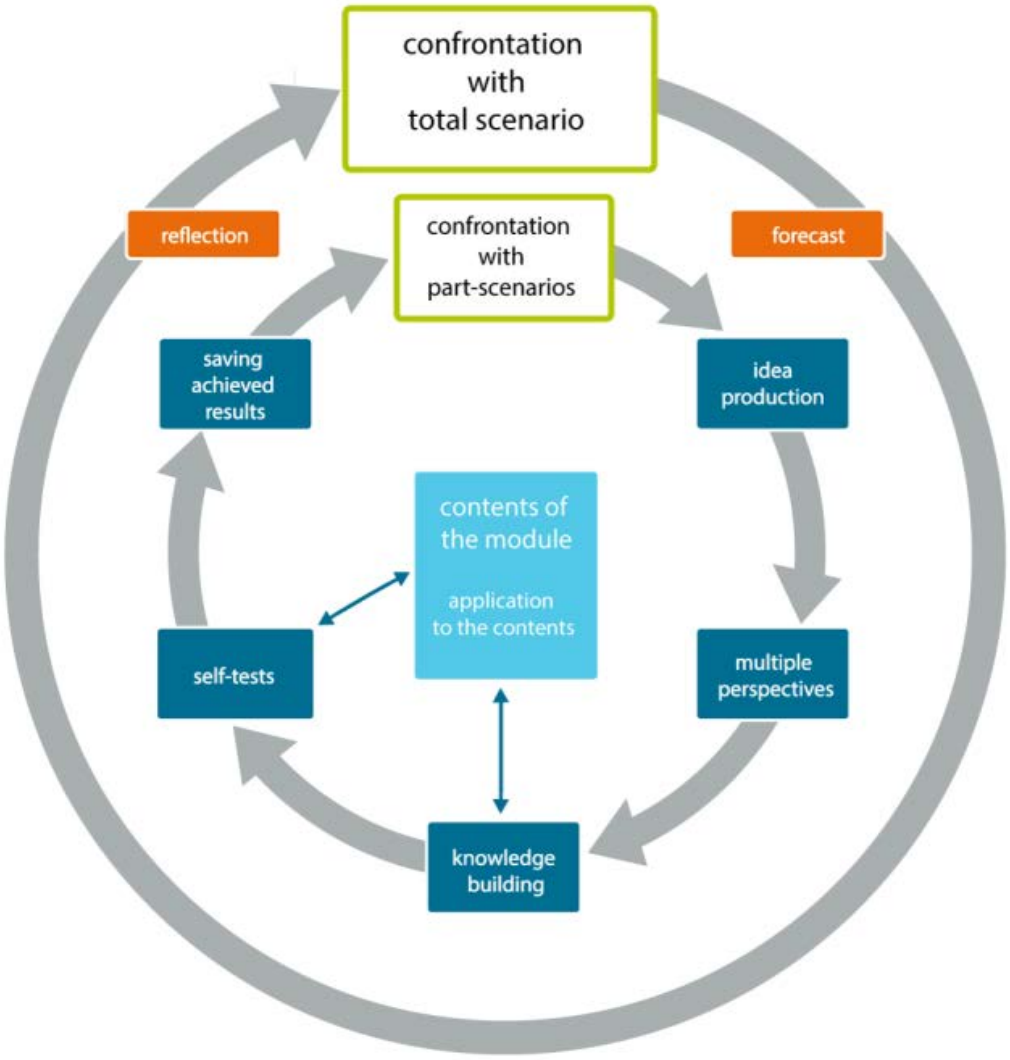

Fig. 3: The didactic method of scenario-based learning in cycles: SBLiC (Weichler et al, 2015a / Weichler et al, 2015b)

3. Syllabus and Learning Objectives

The first main focus of the course is to ensure that the participants are able to analyze different heating systems and are able to explain the function of each component. The second main focus is to generate knowledge about the possibilities of integrating solar thermal energy in heating systems and processes (for example domestic hot water preparation and heating support). Overview of the syllabus and learning objectives is provided in the figure 4 below.

The entire course can be broadly divided into three sections. The first section describes and provides a general overview of different methods used to produce heat. This includes heat supply using conventional as well as renewable sources. The second section focuses on Solar Thermal technology, wherein students learn about solar thermal systems through in-depth study of solar thermal components, various applications of the technology, technical characterization, manufacturing processes, and simulation tools among others. The third section deals with the socio-economic and political aspects of Solar Thermal technology.

		Learning objectives Participants...
whole module		... can analyze different heating systems and explain the function of each component. ... know the main possibilities for integrating solar thermal energy in heating systems and processes.
motivation & introduction	1	... know different aspects of solar architecture and are sensitized on aesthetics.
	2	... know the potential for the solar thermal energy.
solar thermal energy conversion	3	... can explain the possibilities of producing heat in renewable and conventional ways.
	4	
	5	... know the main regulations for buildings and can explain different opportunities for solar thermal integration with an appealing aesthetics.
	6	... can describe the functions of the most important solar thermal components.
	7	... can explain the operation mode of the treated systems.
	8	... know the regulation for the certification of solar thermal components and the associated tests.
	9	... can explain treated manufacturing processes.
	10	... are able to perform a software-based simulation and evaluate the results.
	11	... know the dimensions of the energy transition. ... know the functional tests for solar thermal collectors and know where the problems occur.

Fig. 4: Course plan and learning objectives of the CAS course "Understanding Solar Thermal Energy Conversion USTEC"

4. Learning Platform and Online Learning Tools

For the e-learning phase, the open source software ILIAS is used as the learning platform. ILIAS has a wide range of functions that make e-learning varied, activating and motivating. Following tools and new media are used in the course: glossary, wiki, library, blog, peer feedbacks, self-tests, e-lectures, learning materials in pdf-format, quizzes, evaluations, interactive videos, learning locations, calendar, booking functions for consulting hours and topic assignment, mails and discussion forums in addition to the online meeting room. ILIAS and all tools and media on ILIAS are browser-based, so no special software installation is necessary and ILIAS is responsive, that means it is possible to use it with smartphone, tablet computer or desktop computer. Learning materials are in pdf-format which can be used online as well as offline.

Networking between participants, and between lecturers and participants is a part of the course program and is supported by various online tools. This CAS module is one of the first online formats that successfully uses guided peer-feedback with the peer-feedback tool provided by ILIAS to give the participants response to their term or seminar papers and promotes exchange between participants. In addition, following networking methods are deployed: forum, online-meetings, workspace for learning-groups, participant profiles, e-mail, blog and consulting hours.

5. Acknowledgments

The development and construction of new forward-looking continuing education consumed huge amount of work, research and dedication. Still, implementation would not have been possible if we did not have a support of many individuals and organizations. Therefore we would like to extend our sincere gratitude to all of them.

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