

# Master's Courses at Solar Energy Conferences

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## Abstract

Bringing master's students closer to established scientists and scientific content was the main underlying idea for establishing a master's course in connection with international solar energy conferences in the early 2000s. Since then, the course has been held at eleven conferences and will take place for the twelfth time at EuroSun 2022. The organisation of the course spreads over four to six months but the work of the students on the technical content is concentrated over two to three weeks, culminating in active participation in the conference for one week. In addition to participating in networking activities, students work in pair on an assigned topic, attend the conference sessions on their topic and present their findings on the last day of the course. The results of a retrospective evaluation survey conducted at the end of 2021 show that the course was overwhelmingly a positive experience for the 26 former students who responded and that, for most of them, it had a positive impact on their following studies and careers. Due to the universal character of conferences in the scientific world, the concept can be replicated, with a few basic requirements, for other regional or thematic target groups. By sharing practical advice and lessons learned from previous editions of the course, the authors aim to facilitate this process.

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## 1. Introduction

Scientific conferences, especially international ones, offer established and young researchers, often doctoral students, the opportunity to exchange content, to identify research trends and to build and maintain networks. In principle, undergraduate and master's students can also participate in international conferences. This is often encouraged with discounted conference fees. Diverse studies in literature, mostly with undergraduate students, showed that the participation of students in conferences confirms or even reinforces their interest in research, both for their further studies and for their future professional life. These benefits have been found both for students who present their work at conferences (Mabrouk, 2009; Kneale et al., 2016) and also for those who attend only as audience members (Hall, 2015).

Involving students in scientific conferences is not a new idea. Specially dedicated Undergraduate Research Conferences exist in different research fields and are notably widespread in the Anglo-Saxon world (Kneale et al., 2016). Presenting results at "normal" conferences is also an option and the impact on undergraduate students was studied for instance by Mabrouk (2009) in the field of chemistry. Two years in a row, Mabrouk submitted a survey to undergraduate research students who presented their findings in a dedicated poster session at a national US American conference. Of the 81 students who responded to the survey, 94 % rated their experience with the conference as "life changing or positive". It also motivated them to continue their undergraduate research project (40 % very strongly).

Since 2000 an innovative approach, so far with no equivalent found in literature, has been developed. It is dedicated to graduate students studying a master's degree with knowledge in the field of solar energy, solar buildings and related topics. It consists in bringing international students together at an international conference related to solar energy in the framework of a master's course. In this contribution, the objectives as well as the detailed organisational aspects of the course are presented. Lessons learned along the years are shared to facilitate future reproductions of the concept. The results of a retrospective survey sent to former students are also presented.

## 2. Starting point and objectives of the course

There are many barriers limiting the access of students to scientific conferences. In addition to financial restrictions, the main obstacles are uncertainties about entering a professional environment that is completely new to them. This takes away the opportunity to come into direct contact with established academics, which could be very helpful for writing master's theses and for a well-founded assessment of doctoral options. Also, students who leave the university directly after graduation would otherwise most likely never get an impression of a scientific conference.

Based on this situation, the master's course has been initiated in 2000 in connection with the EuroSun Conference and the Solar World Congress (SWC), two biennial conferences related to the field of solar energy and organised by the International Solar Energy Society (ISES) and a host institution. Since then, the course has been held at nine EuroSun conferences (2000, 2004, 2006, 2008, 2010, 2012, 2014, 2016 and 2018) and twice at the SWC (2011 and 2021). The course at the last SWC took place for the first time online, as the conference was held virtually due to the COVID-19 pandemic. The course will take place this year again at EuroSun 2022. Along the years with the experience gained and external constraints, some features of the course have evolved. Nevertheless, the main goals and features of the master's course remain the same since its introduction and consist in (a) proposing an organisationally and financially attractive opportunity for students to participate in an international conference, (b) creating an atmosphere in which students feel safe and confident at the conference, (c) fostering opportunities for international networking with other students and doctoral candidates, but especially with established scientists, and (d) providing cutting-edge scientific knowledge on the topics of the conference.

## 3. Organisation of the course

The course is mainly organised by one or two professors and their assistants, depending on the years. The first author of this paper who initiated the course usually pairs with a professor from the host institution of the conference. The professors and assistants, also named lecturers in the following, are in charge of the practical organisation of the course, the communication with the conference organisers and ISES as well as the supervision and evaluation of the students.

The course is open to a maximum of 20 international students. The course and conference language is English. Students meet in person at the location of the conference which lasts between three to four days and is organised every second year in a different country in Europe (EuroSun) or in the world (SWC). Even though the main, in-person, part of the course is concentrated over the week of the conference, which usually takes place in autumn, the preparation for the course stretches over four to six months. A detailed time schedule is shown in Fig. 1.

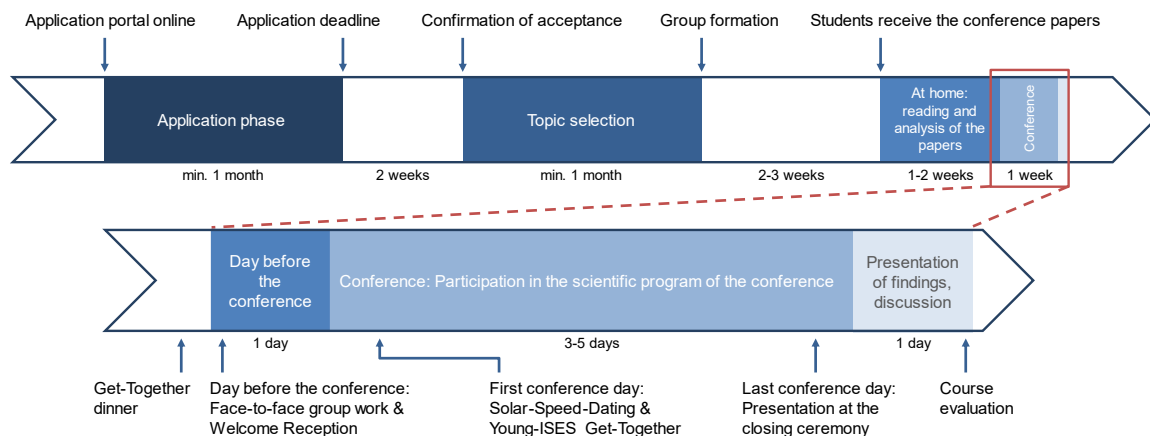


Fig. 1: Schematic timeline of the master's course

Application for the course is the first step and takes place online four to six months before the conference. The course is advertised worldwide through various networks, so that the composition of the group is very international. Students are offered a free access to the conference from the conference organisers but must pay for their own travel and (part of) accommodation costs. During the selection process, in addition to the educational background of the students, attention is paid to the greatest possible diversity in terms of fields of study, countries

of origin, languages and gender. After confirming their participation, the students choose each three to four topics of their choice from the 15 to 20 different themes of the conference. Topics could be, for example, “Solar heat for industrial processes”, “Innovative photovoltaic systems” or “Thermal Energy Storage”. On this basis, international pairs are formed, i.e. a maximum of 10 groups in total, each of which concentrates on one of the topics during the course.

One to two weeks before the conference, the students start working on the technical content. They receive the long version of the conference papers submitted by the conference participants and should read, analyse and discuss the contents with their respective partners. The goal is to come to the conference with already an in-depth knowledge of the conference contributions on the topic that was assigned to their group. This preparation makes it easier for them to follow the scientific discussions and interact with the authors during the conference. On the last day of the course, which takes place the day after the conference ended, the students present the content-related findings on their topic to the other students and the lecturers. In their group presentation, they give a brief overview of the current state of research on their topic. Then they present the two to three conference papers they consider most relevant and critically discuss their findings. Following each 20-minutes presentation, a discussion of about the same length ensues with the group of students and the lecturers. At the end of the presentation day, the course is evaluated in a joint discussion round.

#### 4. Originality of the teaching concept

The teaching concept is unique – no equivalent is known to the authors or could be found in literature – and the objectives, listed above, are much broader than simply learning technical skills on a given topic.

As reported by Hall (2015) quoting a student, after an experiment bringing undergraduate students to a conference “the students felt a little uncertain about their presence as [...] “the role of the student at the conference was not set out clearly””. The concept of the master’s course presented here tries to overcome this issue in creating an environment where the students feel at ease during the conference. This is achieved with the organization of several networking activities and involvement in the activities of the conference. On the evening before the welcome reception, students and lecturers meet for the first time personally at a joint dinner in a suitable location. The day before the start of the official technical content of the conference, a room with internet access is available to the student for joint content-related work. On the first day of the conference, a “solar-speed-dating” event as well as a young professional get-together event are organised by the ISES. The students of the master’s course are encouraged to participate in both events which are open to all students, PhD candidates and young professionals participating in the conference. During the “solar-speed-dating” small groups of four to six students and young professionals can exchange ideas with established experts on a previously selected topic. After 20 to 30 minutes, groups and topics change. This is repeated once or two times. Overall, these events are explicitly intended to help students of the course to get to know more conference participants in an informal way and specifically to reduce inhibitions about approaching established scientists. This all contributes to the fact that the students already know a relevant part of the participants at the conference and no longer feel isolated. Pictures illustrating shared moments during the course are presented in Fig. 2.



**Fig. 2: Pictures of shared moments during the course: group photo at EuroSun 2006 in Glasgow, United Kingdom (left), students working in group on their presentations at EuroSun 2008 in Lisbon, Portugal (center) and get-together dinner at EuroSun 2014 in Aix-les-Bains, France (right).**

Furthermore, when preparing for their final presentation, students are encouraged to talk to the authors to discuss the results and more practically to get their slides as material for the final presentation. Also, during the week of the conference, a daily time slot is arranged for the students to meet with the lecturers to ask organisational and

content-related questions, or questions regarding the conference in general. Last but not least the students are given the task of presenting their motivation, impressions and gained knowledge as well as a message to the solar community in five to ten minutes during the closing ceremony. They do not get real guidelines for this presentation, so the content varies in an original way from year to year. Pictures of presentations during the closing ceremony are shown in Fig. 3.



Fig. 3: Pictures of presentations of the master's course during the closing ceremony at EuroSun 2004 in Freiburg, Germany (left), EuroSun 2012 in Rijeka, Croatia (center) and EuroSun 2016 in Palma de Mallorca, Spain (right).

Emphasis is also placed on improving the presentation skills of the students. During the discussion round following each presentation on the last day of the course, students are asked to evaluate their own performance. Did everything go as planned? Were they too nervous? Did they always look at the audience as they had planned? In addition to the content of the presentation, the discussion provides suggestions for improving the presentation technique and the structure of the slides. Pictures taken during the last day of the course are shown in Fig. 4.



Fig. 4: Pictures of the last day of the course during the final presentations of the students at EuroSun 2010 in Graz, Austria (left), EuroSun 2012 in Rijeka, Croatia (center) and EuroSun 2018 in Rapperswil, Switzerland (right).

Overall, the students work intensively over a period of two to three weeks in an international environment that was previously unknown to them. They learn to manage their time very well. In addition to their topic, for which they have to prepare their final presentation, they naturally have the opportunity to participate in all the other sessions and events of the conference. With these different features of the course, the students learn (a) working in an international environment, for almost all of them in a foreign language, (b) cutting-edge knowledge of current developments in the field of solar energy, (c) time management under time pressure, (d) presentation techniques and self-criticism, (e) networking competences with international students, doctoral students, and experts. Moreover, their fear of contact with science in general and with established scientists in particular is reduced.

## 5. Retrospective evaluation of the course

To grasp the long-term impact of the course on the students, a short survey with 16 multiple choices questions and one final open question was sent at the end of 2021 to all participants of nine editions of the course between 2004 and 2018. The email addresses gathered along the years were used for this purpose and 155 people contacted. With 26 full questionnaires answered the response rate of 16.7 % is relatively low and is certainly mostly linked to the delay between the events and receipt of the survey. A first hurdle was the validity of the contact data as 26 % of the sent emails resulted in a "Delivery Status Notification (failure)".

In the following the main results of the survey are presented in Fig. 6 to Fig. 10. For each question, the number of respondents  $n$  is specified. The questions as they are formulated in the survey are given in the title of the figures. When assessing the results, it should be borne in mind that a long period of time had elapsed between the course

and the survey, more than 15 years for some of the respondents. The survey was anonymous, but the year the students participated in the course was asked. An overview is presented in Fig. 5. Interestingly students from all nine courses responded, except from EuroSun 2004 for which the share of invalid email addresses is especially high (64 %).

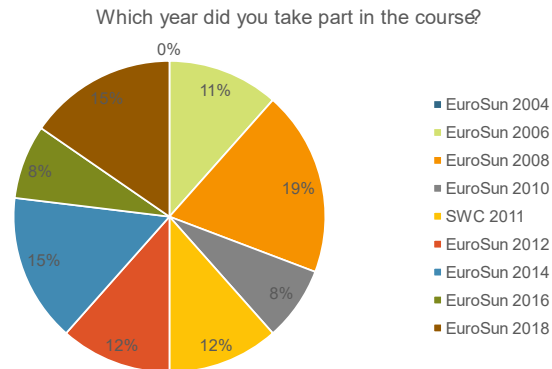


Fig. 5: Year of course participation of the respondents to the survey (n = 26).

A few general questions were asked first. For the large majority of the respondents (84 %) the course was their first participation at an International Conference (Fig. 6, left). Most of them (60 %) are not in contact anymore with other course participants (Fig. 6, right). For those who do (10 respondents), the number of former students they are still in contact with was asked in a text field and varies between one and three (2.3 in average). One answer is unprecise (“less than 10”).

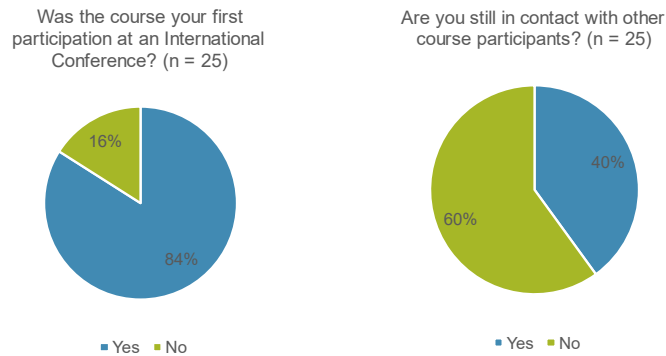
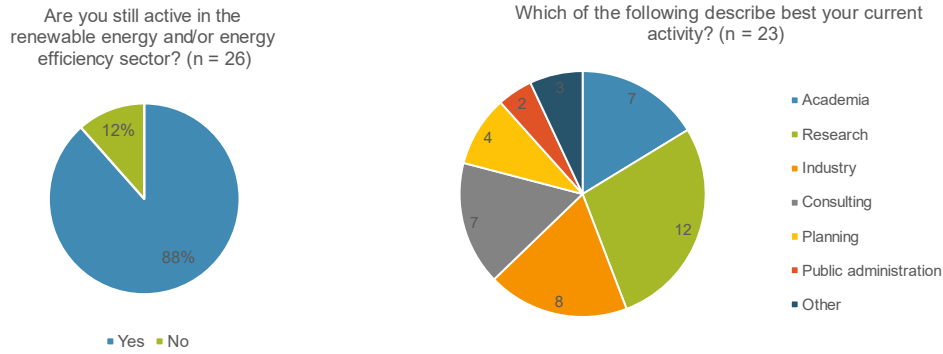


Fig. 6: Answers of the respondents to two general yes and no questions.

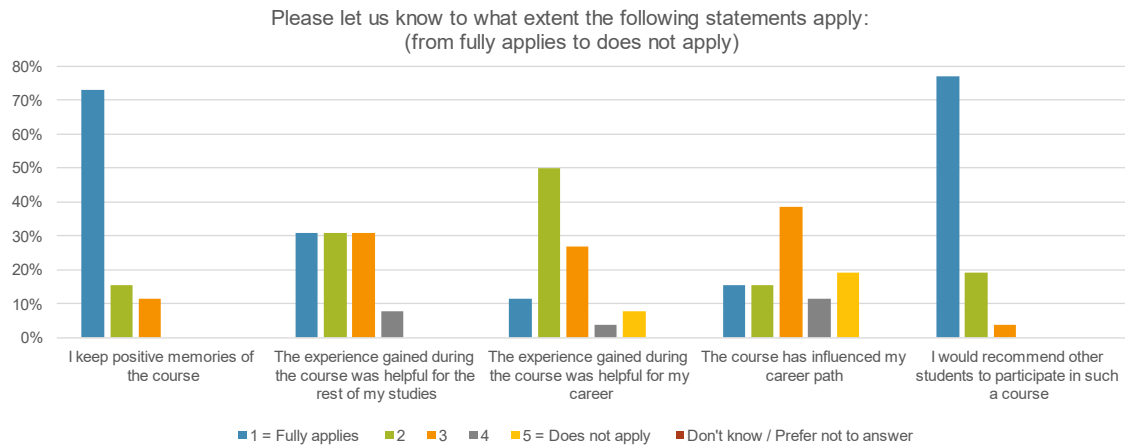
The large majority (88 %) of the respondents is still active in the renewable energy and/or the energy efficiency sector (Fig. 7, left). Further details about the current activity of the respondents who positively answered the question “Are you still active in the renewable energy and/or energy efficiency sector?” are shown in Fig. 7 (right). Several choices were possible to answer the question “Which of the following describe best your current activity?”. The checkbox “Other” was accompanied with a text field for specifications. Overall, more than half of the respondents (52 %) are still involved with research, and seven of them (30 %) are connected to academia. Industry (35 %), consulting (30 %) and planning (17 %) are the other main fields the current activity of the respondents is related to.

After the general questions, more specific questions related to a retrospective evaluation of the courses were asked. The answers to a first set of questions are presented in Fig. 8. For each question the scale goes from 1 (fully applies) to 5 (does not apply), with the possibility not to answer. Overall, the course was a positive experience for the respondents, 73 % keeping positive memories of the course (fully applies) and 77 % would recommend other students to participate in a similar course (fully applies). For most of the respondents the experience gained during the course was significantly helpful for the rest of their studies (62 % in categories 1 and 2), as well as for their careers (62 % in categories 1 and 2), even though less significantly for the latter. The impact of the course on the career path is less marked, as it is significant (categories 1 and 2) in 30 % of cases. For 31 % of the respondents the course had a limited or no impact on their career path (categories 4 and 5).



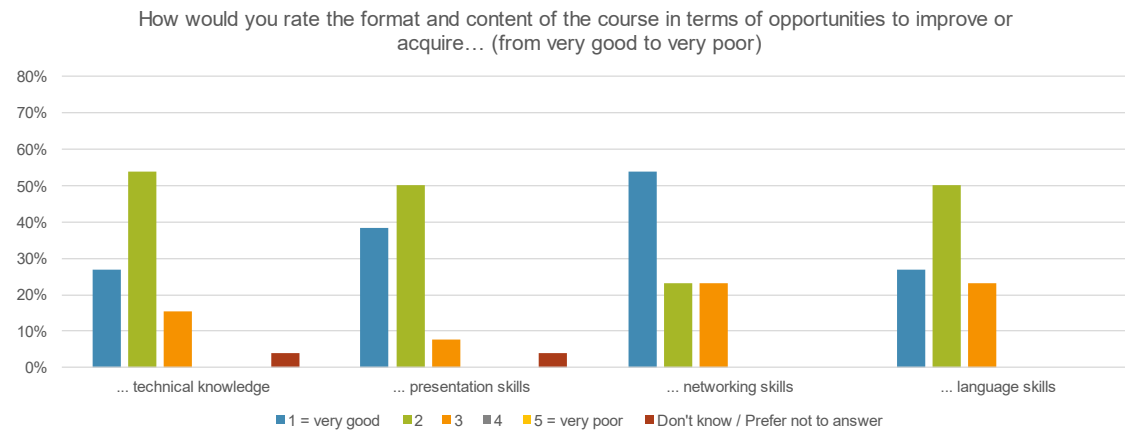
**Fig. 7: Answers of the respondents to the questions related to their current activity. Multiple choices were possible for the question “Which of the following describe best your current activity?” (right) and only the answers of the respondents who answered yes to the question “Are you still active in the renewable energy and/or energy efficiency sector?” (left) are integrated.**

The participants to the survey were also asked to evaluate the pedagogical content of the course on four different aspects from a scale from 1 (very good) to 5 (very poor), with the possibility not to answer (Fig. 9). Opportunities to improve or acquire knowledge and skills is rated very good in 54 % of the cases for the networking skills, 38 % for the presentation skills and 27 % for the language skills and the technical knowledge. It is rated good in 54 % of the cases for the technical knowledge, 50 % for the presentation and language skills and 23 % for the networking skills.



**Fig. 8: Answers of the respondents to the questions related to the retrospective evaluation of the courses (n = 26).**

Finally, an overall evaluation of the course was asked (Fig. 10) on a scale from 1 (very good) to 5 (very poor), with the possibility not to answer. 92 % of the respondents positively rate the course (categories 1 and 2), among which 42 %-point give a very good assessment.



**Fig. 9: Answers of the respondents regarding the pedagogical aspects of the course (n = 26).**

Even though the low response rate to the survey leads to an imperfect representation of the opinion of the former students who participated in the course, the responses obtained are in line with the objectives of the course. For most of them the course was their first participation in an international conference. It is not a direct objective of the course but interestingly the majority of the respondents are still working in the research field or even in academia for almost a third of them, which is high considering that in 2019 in the EU27 2.8 million people were working as researcher, which represents 3.5 % of the population aged 15..64 with tertiary education (Eurostat, 2022a, 2022b; World Bank, 2019). The causal relationship between having participated in the course and a high inclination to work in the academic and research field cannot be inferred from the survey data. It can however be noticed that three (43 %) of the respondents still active in academia responded with fully applies to the statement “The course has influenced my career path”. Two answers to the final open question “Would you like to add one or two sentences about you and the course?” from former students still active in the research field are even more explicit as one states that “[the course] has helped shape [her/his] career” and the second that “participat[ing] at an international scientific conference as a student encouraged [her/him] to pursue a career in research”.

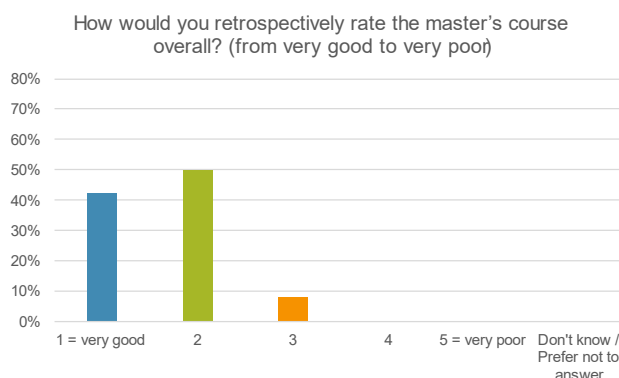


Fig. 10: Answers of the respondents to the overall evaluation of the course (n = 26).

Concerning the opportunity to learn new skills, networking is rated at the highest among the four assessed, which is not surprising giving the context of the course organised with various group activities at a scientific conference which is by essence centred around networking. This is also reflected in the fact that a non-negligible share of the respondents remains in contact with former course students. The method chosen to evaluate the presentation of the students in the last day of the course as detailed in section 4 also seems to be successful as the opportunity to learn presentation skills is rated at the second highest.

## 6. Practicalities and lessons learned

The format of the course can basically be multiplied and transferred almost at will, as regular international (European) conferences are also common in other academic disciplines. However, some basic requirements must be met. First, the conference organisers must be willing to provide access to a limited number of students at very attractive conditions, ideally free of charge. For the students to be able to work on the technical contents, the written conference papers must be available in full length (not only abstracts) at least a few days before the conference. The lecturers must also be prepared to bear the significant organisational burden of the course, although only a minority of the participants come from their own universities.

Over the years several organisational aspects have been improved. Especially in recent years, a significant number of students who had registered online for the course and were selected to participate have not kept their commitment, so that they needed to be replaced by students from the waiting list. This is an iterative and time-intensive process. In the worst cases students cancelled in the last days before the conference or (rarely) did not even show up, making it difficult to replace them. To reinforce commitment, it was decided in the last editions of the course to introduce a registration fee as a precondition for participation in the form of a compulsory registration as Young ISES Member. Registration costs of 22 € (half for students from low-income countries) are acceptable for students and act as a commitment check. Registration as Young ISES Member is an existing procedure that has been preferred to a direct fee transfer for instance which would require greater administrative efforts. During the month of topic selection (Fig. 1), students must confirm their participation by completing Young ISES Member registration. Students who did not complete their registration after a given deadline are replaced by others from

the waiting list until the group reaches 20 students or the waiting list is exhausted.

Shared accommodation was suggested by the students to encourage group dynamics, so where possible, rooms for the students are pre-booked in a youth hostel at the conference venue. In recent editions of the course, funds have been raised to subsidise (part of) the accommodation costs of students staying at the youth hostel. On the one hand, this reduces the financial burden on the students who have to finance their travel costs, and on the other hand, it prevents students from choosing alternative accommodation, in which case the creation of a group dynamic would be hindered.

All in all, participation in the course requires more financial and organisational efforts from the students than participation in regular courses at their own universities. These unavoidable barriers to participation act as “motivational check” so that the participants are often already highly motivated and committed students, eager to learn more about solar energy and renewable energy in general.

Besides the various financial incentives, the students receive at the end of the course a graded certificate of achievement from the home universities of the lecturers. The grade is awarded based on their final presentations and corresponds to an assumed workload of 90 hours or three ECTS credits. Thus, by having the certificate recognised at their home university, students can ensure that the work invested in the course also counts towards their studies. To date, there is no known case of a university in Europe not wanting to recognise this certificate of achievement in a relevant master’s programme.

In terms of technical content, a wide choice of topics is available, but students are always assigned one of the three or four topics they have selected. Conference themes are thematically grouped together when necessary to form the list of topics proposed to the students of the course. This avoids having topics with an unequal number of scientific contributions.

## **7. Conclusions and outlook**

In more than 20 years, eleven conferences and soon twelve, the innovative concept of the master’s course presented in this contribution has proven successful. The course is now well established and is a standard feature of the EuroSun conferences. According to the informal feedback the authors have received, other conference participants are usually pleased to see young scientists participating enthusiastically and therefore happy to answer their questions. In addition, the course is often mentioned as one of the conference highlights in the speeches at the closing ceremony.

The answers to a retrospective evaluation survey sent to former students confirm that the vast majority of the 26 respondents had a positive experience of the course. Besides the opportunity to improve or acquire various skills and knowledge, it appears that the course had a substantial impact on their following studies and even on their careers. It is interesting to note that most of the survey respondents are still involved in research in their current activity.

With this contribution, the authors encourage others to replicate the concept, which should be possible in most academic fields with only a few basic requirements. The main hurdle is probably the time needed to organise the course. Over time the authors have developed and improved material such as an online registration form, a detailed timetable for the organisation of the course, answers to frequently asked questions or standard emails for communication which could be shared with interested parties on request.

## **8. Acknowledgments**

The authors are thankful to the former students of the course for responding to the survey that was sent to them.

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