
Development of training materials for micro-entrepreneurs in solar energy for rural Cambodia



Report

Bachelor project

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Summary

This report covers the design process of training materials for future micro entrepreneurs in solar energy products. The project has been executed in collaboration with Kamworks, a solar energy company in Cambodia.

The problem

In the rural areas of Cambodia only a few people have access to a reliable public grid for electricity supply. Solar electricity could be very useful for these people (Boom, 2005).

For this reason Kamworks was established as a Cambodian solar energy company in 2006. The mission of Kamworks is to provide affordable energy systems in Cambodia in order to contribute to a sustainable development of this country. At the moment Kamworks installs solar panels in Cambodia. The company is starting the production of a solar lantern and wants to produce more solar energy products for the Cambodian market. To sell these products, Kamworks must reach the local market. Kamworks wants to do this by training young Cambodian people in commercial and in technical skills, in order to let them start their own micro entrepreneurship in solar energy products. For the commercial training Kamworks wants to use existing training materials, but for the technical training new educational materials have to be developed. Development of these training materials is the goal of this project.

Research

Prior to designing the training, a research has been carried out to understand the differences in communication and in education between Cambodia and the Netherlands. A primary school was visited, pupils and young people were interviewed and different schoolbooks were studied. By reading literature and by getting to know Cambodian people differences and similarities in communication between Cambodia and the Netherlands were discovered. With the gathered information training materials for Cambodian people were developed.

Educational targets

To find out what kind of information the training has to convey, a literature research has taken place. Many existing trainings about electrical solar energy were studied. Next to this a discussion with Kamworks provided the information necessary for developing the training.

Developing training materials

With the formulated educational targets and the knowledge about the Cambodian education and communication, training materials were developed. The main part of the training materials consists of a training book. The book is supplemented with materials for practical use, a manual for the trainer, a course program, tests and a certificate.

Adaptations and recommendations

When the development of the training materials was finished, a pilot training was started. Six trainees with different backgrounds participated in the training. During this training certain aspects were found that need to be improved in the future. After the training the trainees were interviewed to get an idea of their opinions of the training. With the gathered information an improved training and recommendations for future research / work were made.

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Preface

This report is the result of my bachelor project at the Faculty of Industrial Design Engineering at the University of Twente.

It was a great experience to perform the bachelor graduation project in another county and culture. Besides the things I have learned and experienced in an individual project for a company, I also experienced what it is like to work in a country with a completely different culture.

I started the project in the Netherlands, but after a month I went to Cambodia and directly I experienced a culture shock. Despite the fact that there is a lot of poverty, all the people were laughing and very friendly. Cambodians really like to help you all the time. It is nice to work with such motivated people. Unfortunately I experienced that the education system is very bad. For all these reasons I was very motivated to develop a good training and to train people to assist them finding a good job and earn some money. I gave the pilot training with a great enthusiasm and I liked that the trainees were trying their very best. But there were also small disappointments. It was a pity when I tried to use some drama and examples in the training which the translator could not pass on to the students.

Looking back on the time in Cambodia I have had a great time and I consider the project useful and successful!

For all this I want to thank the following people: Angèle Reinders for the support from the university. A lot of thanks goes to Arjen and Henry for the all the help and support when I needed it. I really want to thank Leap for translating all the documents in Khmer, for the fact that he was always ready to help me and for his jokes. Also Veasna for being my translator during the pilot training and the trainees who followed the pilot training with great enthusiasm. And of course all the other people who assisted me in other ways.

A special thank goes out to my friends and family who supported me the whole time.

Thank you,

Jony



Figure 1: Friends in Cambodia

Introduction

For most of the people in Cambodia it is not natural to have power from a public grid. Only around 15 percent of the Cambodian population has continuous access to electricity via a reliable public grid, and most of this group is in Phnom Penh. For the rural population less than 9% have access to an electricity grid. Solar electricity could be an economical and clean solution for these people (Boom, 2005).

Kamworks

For this reason Kamworks was established as a Cambodian solar energy company in 2006 (figure 2 and 3). The mission of Kamworks is to provide affordable energy systems in Cambodia in order to contribute to a sustainable development of this country. This mission is translated to two long term goals. The first goal reads: *'Create employment for Cambodian young people from a poor background, such as orphans'*.

It is difficult for these people to raise an income in a country where employment is closely connected to a family network. Kamworks wants to fulfill its mission *'affordable energy for sustainable development'* by a



Figure 2: Kamworks

commercial approach, thereby creating jobs for this vulnerable target group. The employees are given the opportunity to develop themselves and to explore their own best talents during a traineeship that will take place during the first years of employment. On a practical level, this means that some employees will recognize their best skills in a production atmosphere. Others will explore their skills in a more independent and commercial way and will possibly set-up their own trade activities as micro entrepreneurs.

The second goal reads: *'Provide rural Cambodia with affordable, useful and high quality solar-energy products'*.

Kamworks works on this mission by two types of activities. In the first place the company sells and installs solar electricity systems for professional end-users that have a need for electricity in the rural areas. In the second place, the company produces small products based on solar electricity for the consumer market. For its first activities, Kamworks acquired some dealerships in Cambodia. For the second activities, preparations are carried out to start up production this year.

Background

In Cambodia employment is closely connected to a family network. Most people take care for themselves as a farmer, or earn money with a small-scale family company. Small shops and trades are passed on from father to son, or from mother to daughter (see figure 4 and 5). The small products produced by Kamworks can be sold by a such a micro entrepreneur. Kamworks will



Figure 3: Location of Kamworks

Training materials for micro-entrepreneurs in solar energy for rural Cambodia

teach a group of 10-15 people to become a micro entrepreneurs.

The training has to be very practical. Two courses will be developed to provide the micro entrepreneurs with theoretical basic knowledge.

A technical training which provides basic knowledge about solar electricity.

A commercial training which provides commercial skills

The technical training takes 2 weeks and the commercial training 4-6 weeks. For the commercial training Kamworks will use existed materials. The technical training has to be developed by Kamworks themselves.

Objective

The objective of the assignment is to design and develop technical training materials for future micro entrepreneurs. The training provides basic knowledge about solar electricity, which is needed to become a micro entrepreneur in selling solar energy products in Cambodia.

First the current knowledge and skills of the future micro entrepreneurs will be enquired and also the required knowledge and skills a micro entrepreneur needs.

Secondly several existing training programs on electrical solar energy will be studied.

With the acquired results requirements educational and additional targets for the training will be set up.

After this different forms of communication between trainer and future micro entrepreneurs will be discussed.

Technical training materials will be designed and developed and a two weeks pilot training will be given to five trainees, who correspond with the target group. This pilot training will be evaluated. The results of the evaluation will be used to develop recommendations for an improved training and to design and develop an improved training.

All this will happen in a time period of 12 weeks.



Figure 4: Small mobile food shop



Figure 5: Small Cambodian shop

Differences in culture

Cambodians are very friendly and helpful people and in general there are no problems in communication between Cambodian and western people, since most Cambodians have at least basis knowledge of the English language. But there are lots of differences in culture. Adapting to the Cambodian culture will facilitate the communication between Cambodians and foreigners.

Communication

In Asia emotions are not shown as clearly as in Europe. It is very impolite to lose temper or to raise one's voice. It leads to loss of prestige of the Asiatic people. It is also unusual to contradict someone. Cambodian people stay calm and if there really is a problem, the best solution is to explain it patiently with a friendly smile.

Cambodian people think white western people have a lot of money and are powerful. For this reason white people have a high rank, especially when they are doing an important task.

The body is very important in Cambodian contact. The head is the most important part of the body. It is very important not to touch someone's head. For acquaintance the hands are fold before the breast. Cambodian people do not shake the hands, because of hygienic reasons, but some people are getting used to it. The left hand is not used to touch other people, because this hand is used for sanitary facilities. For this reason Cambodian people use both or only the right hand to

	Primary		Lower secondary		Upper secondary	
	F	M	F	M	F	M
Urban	90.4	92.8	40.5	42.1	21.1	24.3
Rural	91.2	93.5	22.2	25.1	4.7	7.5
Remote	79.4	85.4	4.1	3.8	0.1	0.2
Nation	90.7	93.1	24.8	27.3	7.9	10.6

Table 1: Net enrolment rate of pupils by region



Figure 6: Primary school in Cambodia

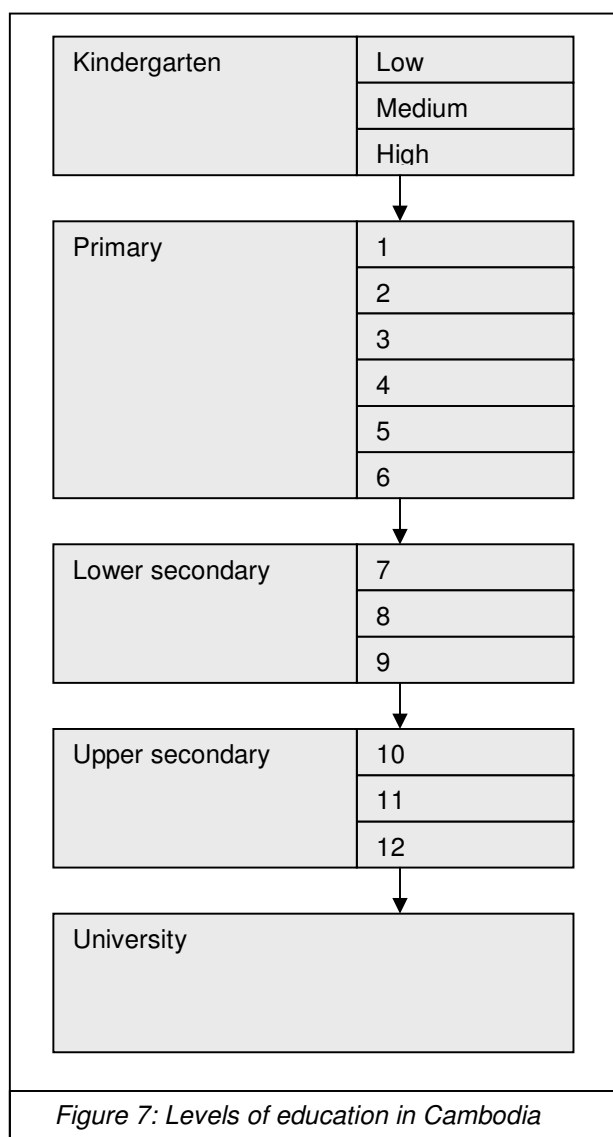
accept and hand over things. The feet are the lowest and the least important of the body. It is impolite to show the soles of the feet. (Peterse and Petri, 2006)

Education in Cambodia

The level of education increases very slowly in Cambodia. During the French colonial period (1887-1953) there was not much attention to educate Khmer. After this period there was progress in the education level. Schools, learning institutions and universities were established. But unfortunately this progress was still for a very short time period. The Khmer Rouge (1975-1979) destroyed everything (Ledgerwood, 2003). For this reason the literacy rate is around 70 percent in Cambodia. It is possible for every child to go to school since it is free. But in the school year 2004 / 2005 only 90 percent of the children who should go to primary school, really went. For the lower and upper secondary school, only about 26 and 9 percent went. In the rural areas of the country less than 25 percent of the children go to secondary school and in the remote parts even less than 5 percent. For exact numbers see Table 1: *Net enrolment rate of pupils by region* But the amount of children going to school increases very fast; each year higher percentage of the children are going to school (Ministry of education, youth and sport, 2005).

Levels of education in Cambodia

When a child reached the age of three year, he or she can go to kindergarten. Kindergarten takes three years. After kindergarten, at an age of about 6 years, children go the primary school (see **Error! Reference source not found.**figure 7) and stay there for six years. After primary



school children are able to read, write and calculate. The lower secondary school takes 3 years just like the upper secondary school. After upper secondary school it is possible to go to university. The education levels are shown schematically in 7 (National Institute of Statistics, 2004).

Way of teaching

To get a good impression of the Cambodian way of teaching a small school in Srê Ampil was visited (Figure 6 and Figure8) and some pupils were interviewed. Other Cambodian people were also interviewed about the way of teaching.

The education level in Cambodia is lower than the education level in the Netherlands, but it increases very fast. Also the educational method differs from the Netherlands. The education is mainly directed one way; the teacher talks and explains and does not give much attention to the pupils, there is only little interaction. When the teacher asks questions and the pupils answer together, or the teacher picks one out. Most of the time the children really like to answer the teacher. During the lessons there is hardly any reference to reality; the children never have any practical courses. The exercises in the books are about reproducing theory. For example in the 12th class the pupils have to make very difficult integrals, but most of the pupils can only reproduce them and do not really understand what the formula is about. The same holds for the science lessons; the pupils get a lot of formulas and numbers (figure 10 shows a science book with a lot of formulas, but no explanations). The pupils can solve the exercises, but do hardly understand what the exercises are about.

Mostly there are more than thirty pupils in one class. Sometimes the teacher goes away for more than 10 minutes and the children simply have to wait until he returns.

Experiences of pupils in Srê Ampil

The pupils said they really like to go to school. They like to learn, because they want a good employment later. The pupils like studying, reading or listening to the teacher the most, because for them this is the best way



Figure 8: Class in Srê Ampil

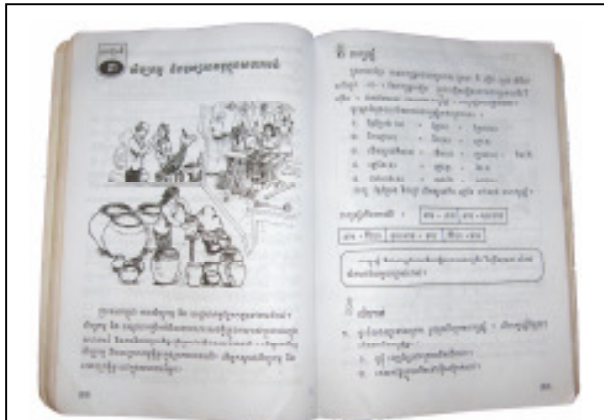


Figure 9: Book for primary school

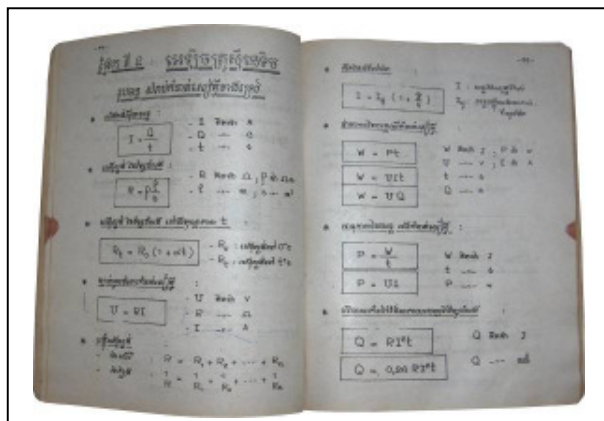


Figure 10: Science book

to learn. For that reason the pupils like the text more than the illustrations in their books. There was hardly anything the children did not like; the children only criticized things that happened outside school. For example they did not like walking to school and back every day. A difficult question for the children was what nice things they could remember. It was striking that one child gave an answer about a car he made with friends, but it was not an exercise for school. The children had never done any practical things for school. But they indicated that they really would like to do practical things.

It is doubtful if the children gave their own opinion or if they had to give the answers they gave. For example a child was questioned if he liked it when the teacher is gone. He answered that he liked this because this gave him the opportunity to play with the other children. But before he said that he liked studying the most. When

asking this of the child he said that he did not like it when the teacher is going away.

Schoolbooks in Cambodia

In Cambodia the schoolbooks consists of text mainly. Pupils prefer text, because they can learn from text, but they also like illustrations. Every schoolbook is just in black and white and all the books look the same; a lot of text, some illustrations and regular use of borders. Figure 9 and Figure 10 show two different Cambodian schoolbooks.

It is important to know that Cambodian people use symbols from the western script. They are familiar with the numbers and sometimes they know the western alphabet. They also use western symbols for electrical abbreviations.

Certificates

Figure 11 shows a Cambodian certificate. When somebody finishes school, a course, training or something similar, it is very important that he or she receives a certificate. So every Cambodian has certificates which are important in trying to get a job. The more important or international names mentioned on the certificate, the more value the certificate has.



Figure 11: Certificate

Training targets

Before developing training materials targets for the training have to be determined. First the current knowledge and skills of the future micro entrepreneurs are enquired and the required knowledge and skills are determined. After that the possibilities for communication and the use of the training building are investigated

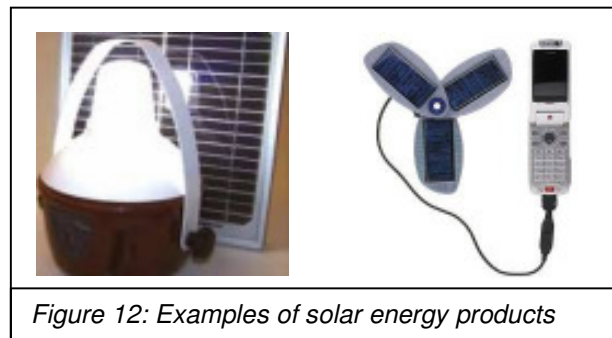
Current knowledge and skills of the future micro entrepreneurs

Cambodian boys and girls between 18 and 25 years old will participate in the training. The future micro entrepreneurs must have (partially) completed their secondary school. It may be assumed that they can read, write and calculate. Probably they can not speak English or just practical English. Because education is very frontal and theoretical in Cambodia, the future micro entrepreneurs may have little practical knowledge and skills. Probably they are good in reproduction, but understanding may hard for them.

Required knowledge and skills of the future micro entrepreneurs

The trainees are trained to become a micro entrepreneur in electrical solar energy products. Examples of products are solar lanterns, solar battery chargers and solar mobile phone chargers (see figure 12). They are also going to sell small 'home lighting kits', containing a small solar panel with a charge controller, battery, wiring and lamps.

The goal of the training is to learn the possibilities and impossibilities of the solar products, how to find and solve a problem of a defect product. The micro



entrepreneur has to know something about electrical solar systems too. To learn all this, the micro entrepreneur has to learn about electricity and solar energy first. He or she also has to be able to perform measurements on a battery and solar panel, to test a charge controller and to acquire other practical skills.

Communication between trainer and future micro entrepreneurs

Because the target group for the training only speaks Khmer and the trainer does not speak Khmer, it is hard to communicate. It is possible to use a lot of illustrations during the training, but it is hard to understand technical information only by using illustrations. Besides Cambodian people like text, because they think they can learn more from text than from illustrations and they also like to go through the text again at a later moment. Because of this it is important that there is text in the training as well as illustrations. Fortunately it is possible to translate the training in Khmer. It is not necessary to translate numbers and technical symbols, because the Cambodian people also use western numbers and technical symbols. To make sure more or less normal teaching is possible, a interpreter is needed during the training.

Training building

The training has to be given in a very simple building showed in Figure . There is just a blackboard and there are some tables and chairs for the teacher and the trainees. In the future it will be possible to show some videotapes.



Educational targets

By using the obtained information and existing literature, educational targets of the technical training for micro entrepreneurs are drawn up. The targets are divided in different groups. The tools which the trainees should use during the training are summarized in the first group. The second group consists of targets about energy, the third about the sun and the fourth about non-electrical solar energy. Targets about solar electricity technology are summarized in the next group. For every part in the electrical solar system (solar panel, battery, charge controller, lamps and wiring) a different group with targets is drawn up. Finally the more practical targets about system design, installation, maintenance and solving problems are written down in the last groups.

The table of educational targets is attached and can be found in appendix 1.

Training materials

Based on the educational and additional targets, training materials are developed. With these materials a pilot training has been given. The basis of the pilot training was a pilot training book with text, illustrations and exercises. Besides the book, materials for practice were developed as well as tests, manuals and a certificate.

Training book

The training book is the basis of the training materials. The English version of the pilot training book as well as the English version of the final training are added separately. A few pages of the Khmer training can be found in appendix 2. The training book consists of text and exercises mainly. When Cambodians see European books with a lot of colors and figures they are very attracted, but it is more expensive and more work to make a European designed book than making a Cambodian designed book. The Cambodians are also used to work with very simple books. For this reason it is tried to design the book like other Cambodian education books. Very simple, just with text, illustrations and some borders. But there are inserted more pictures than normal to make it more attractive. The exercises can be made in the book itself, this way the trainees become the real owner of the book. The pilot training book was printed just in black and white colors, because this is a cheaper solution than a colored book. Headers in Cambodian books are most of the time just bigger or thicker than the other texts. In the training book the headers are placed in a filled border, to separate the headers from the sub headers, because there are many sub headers. In Cambodian books borders are often used. In the training book borders are used to separated exercises and examples. Exercises are placed in a border and examples are not. Also pictures are placed into a border. A filled border is used to emphasize important information.

The training starts with a chapter on measuring and converting units. The first step is on converting meters to centimeters, decimeters etcetera. These very basic computations are useful in estimating the level of the trainees. It is also necessary that the trainees are able to

perform this kind of calculations because in a later chapter they will have to convert watts.

Before starting the subject solar energy, the future micro entrepreneurs have to understand something about energy and power in general. The second chapter (energy) consists of explaining illustrations with added texts. The exercises consist as much as possible of illustrations and numbers, so it is easy to correct, because it is understandable for people who speak Cambodian as well as for people who speak English. This chapter also contains a converting exercise, this time with watt and kilowatt. So converting is repeated fast, this will help the students to understand and remember the method better. There are also a lot of exercises with simple calculations in the second chapter, so the level of the future micro entrepreneurs can be estimated by the trainer again.

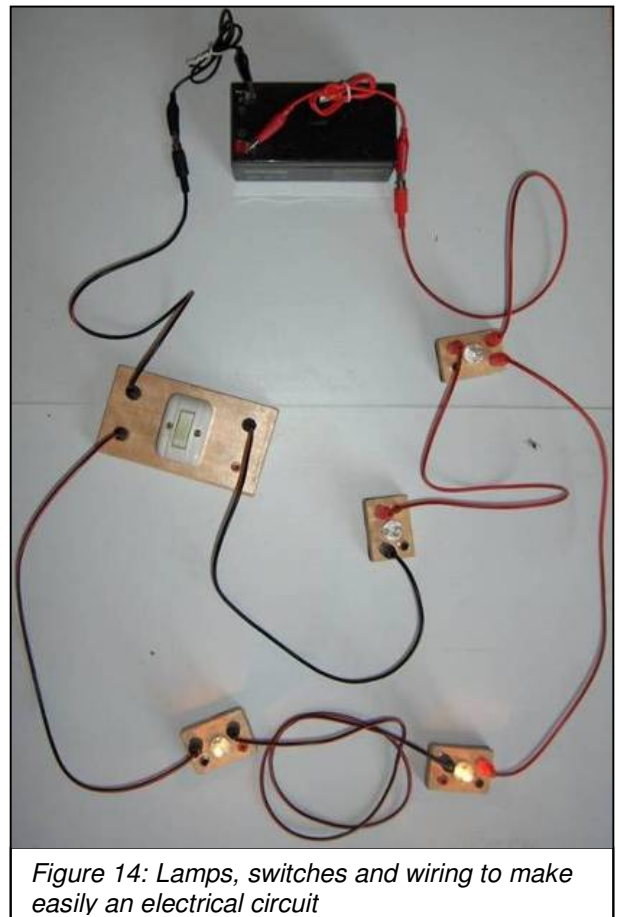


Figure 14: Lamps, switches and wiring to make easily an electrical circuit

Training materials for micro-entrepreneurs in solar energy for rural Cambodia

After this it is time to start with solar energy. The training starts with non-electrical solar energy and after that electrical solar energy. Illustrations of examples of solar energy are shown in the training book and it contains examples of how solar energy can be used in practice. After this the different parts of an electrical solar system are explained very shortly. Before explaining the parts more extensively the trainees have to know something about electronics.

The fifth chapter is about electricity. It explains an electrical circuit, voltage, ampere and resistance. To explain all this, a river is used. In Cambodia the rivers and a big lake are very important. These can be used to explain current, voltage and resistance, because current flows through a wire like water through a river. The harder it is for current to pass a device or wire, the higher the resistance is of this wire or device. Also voltage can be explained, it is like the height of a waterfall. Through the whole circuit the water goes down and the battery has to bring it up again, so the voltage of the battery must equalize the voltage of the different devices in series, like the rain and sea bring water in the lake again. The trainees have to experiment with circuits, so there are many practical exercises in this chapter. For this practical exercises special lamps, switches and wires were made, which easily can be used to make circuits. The materials are shown in figure 14.

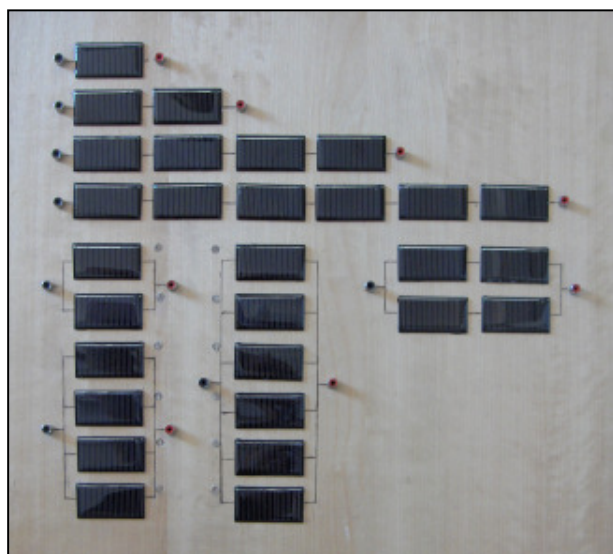


Figure 15: Board with solar cells

The sixth chapter is like the fifth, but about power. It consists of practical exercises and calculations especially.

The most important parts of an electrical solar system are explained in the chapters seven till eleven. Chapter seven starts with the solar panel. The trainees have to understand when the voltage and current are optimal. To explain this, a special board with solar cells and wires was made (figure 15). It is easy to connect the multi-meter to the board and determine the voltage over and current through different cells. As well as a practical part, chapter seven also contains a theoretical part. The trainees learn about solar irradiance and how to perform calculations on a solar panel.

Chapter eight, nine and ten explain the battery, charge controller and inverter. Illustrations with added text are used to explain the devices. Calculations and practical exercises have to be done.

Chapter eleven is about wiring. It starts with some theoretical information and at the end it teaches the future micro entrepreneurs how to calculate the maximum length or minimum diameter of a wire by using a standard method. First the method is explained extensively with a lot of text. The exercises that have to be made are without a lot of text which makes correcting them easy. Chapter twelve uses the same way of explaining on how to design an electrical solar system. Both chapters contain a lot of exercises, because the calculations are a bit complicated. This way the trainees can practice a lot.

Chapter thirteen is a very practical chapter. Figures with added text explain how to use different tools and how to connect an easy electrical solar system. The trainees have to connect a simple electrical solar system to get familiar with the different tools used and how the system is connected in practice.

If the trainees know the different parts of an electrical solar system and know how a system functions, maintenance of the different parts can be explained. Chapter fourteen not only explains the maintenance by using text and illustrations, the trainees also have to do some maintenance in practice.

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The last chapter is about problem solving. Two diagrams will help the trainees to find small problems. During the training the diagrams will be explained and during work they can be useful. The diagrams can just be used for simple problems, because the trainees will not be trained to become an electrician. So for bigger problems the micro entrepreneurs have to ask a specialist.

At the end an appendix and word list are attached. In the appendix the most important information is lined up for the micro entrepreneurs. The word list contains English translations of important words which can be useful for the micro entrepreneurs.

Planning, manual teacher, course program

For the training a two week planning is made. This planning mentions how many hours each chapter from the training book takes and what will be discussed every day. The planning leaves some room for additional exercises and explanation. Also a manual for the teacher is developed. This manual is extensive and mentions exactly what has to happen every day; which chapters will be discussed, when the tests have to be made and so

on. It also mentions what the objectives of each chapter are, what is needed for every chapter and what the trainer and the trainees have to do.

Finally a course program for the trainees is made. In this manual they can see what happens each day, what they have to do at home and when there are tests.

The planning, the manual for the teacher and the course program can be found in the documents for the trainer.

Certificate

As said before in Cambodia it is really important that someone receives a certificate when a training, course or school is finished. For that reason a certificate for this training is designed.

Figure 11 shows a certificate. More examples of certificates can be found in appendix 3. The name of the participant is placed on the certificate as well as the name and sign of the teacher, the name and sign of the director of the school or company, the logo of the school or company and the name and date of the course. Sometimes a certificate also possesses a picture of the participant, the date of birth and some other information. A certificate has a border with a lot of curlicues. The background of a certificate can be empty

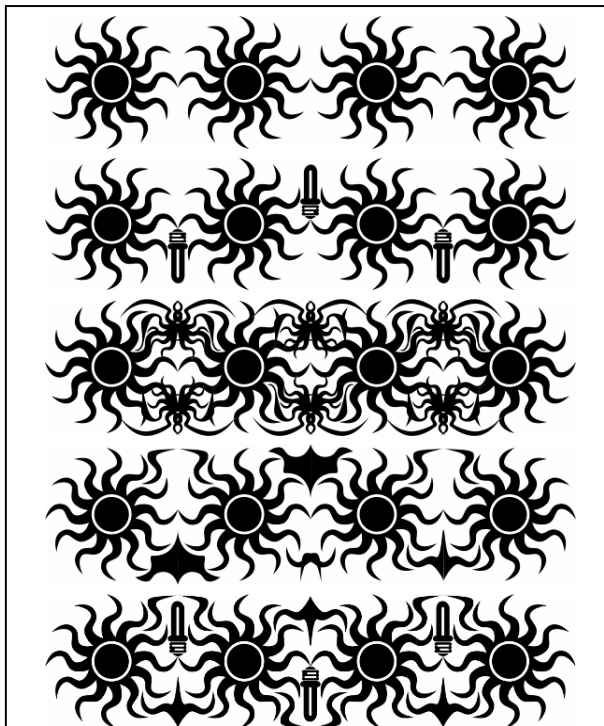


Figure 16: Different designs for the border

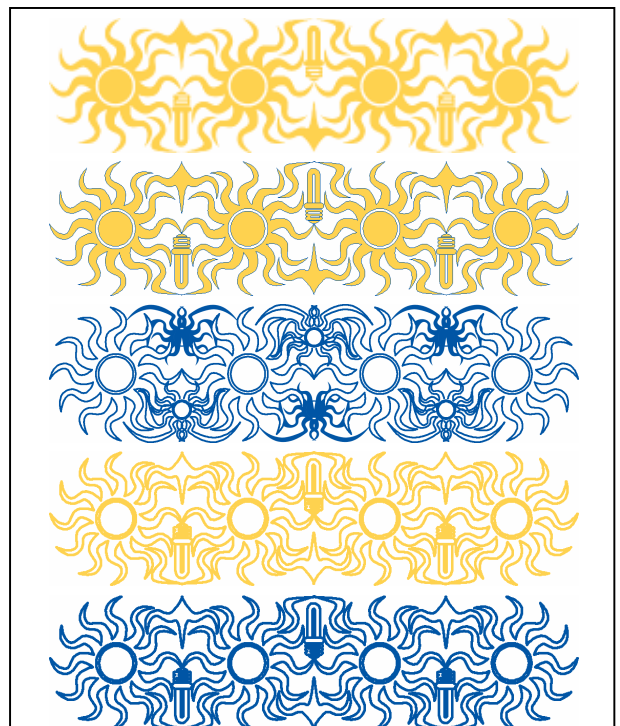


Figure 17: Different colors for the border

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or filled with a logo or illustration.

Design

The designed border for the certificated must have a relation with Kamworks or solar energy. For that reason it consists of graceful suns. To make the border more graceful and fancy different designs were tried. Figure 16 and 17 show different designs and different colors. The border looks more Cambodian when a lot of curlicues are attached and only the sides of the figures are colored. It is very applicable to attach lamps and for that reason the fifth border in Figure 6 is chosen. The blue and yellow colors are the colors which match with the Kamworks

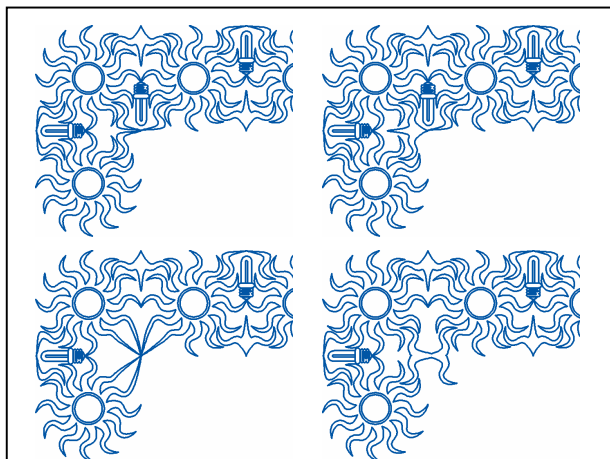


Figure 18: Border corners



Figure 19: Logo in the border

logo. There is chosen for only the blue color because it is more distinctive than yellow. Using two colors is not usual and it looks not very Cambodian.

The next step is to design the border corners. The horizontal and vertical borders can be positioned side by side, but it is nicer to make a fancy corner in the border. But the corners may not attract all the attention, because the attention must go to the content and the Kamworks logo. Figure 18 shows different possible border corners. The corner below left is on the certificate because this one is the most symmetric and certificates are always very symmetric. This corner also has more differences with the border than the other corners, but it is still convenient.

It is usual that the logo of the company or school which distributes the certificate is in the middle of the top side. Different designs are tried to attract the attention to the logo. The designs are shown in Figure. The last design is chosen because this one draws attention to the Kamworks logo. With the big solar beams Kamworks appears as a very important and strong company.

Finally some inside borders are attached as well as a background. The slogan of Kamworks is also in the certificate and a picture of the micro entrepreneur can be attached. Finally the certificate is signed by the company's owner and a stamp is over the picture. The certificates are handed out to the trainees who successfully finished the training (figure 24). A printed certificate without stamps and signs can be found in the documents for the trainer and in figure 20.



Figure 20: Certificate without stamps and signs

Trainees

Before the pilot training can be given, trainees for the training are needed. It is very difficult to find people who are able to follow a full-time two weeks training, because they have to work or to go to school.

Pro-seed

First Pro-seed was approached. The Pro-seed project aims at enhancing energy services in off-grid rural areas of Cambodia. Pro-seed has employed rural lighting service providers (Pro-seed, 2006). The training can be useful for this people. Unfortunately the people were too busy and did not have time for a two weeks full time training.

Don Bosco technical school

Secondly Don Bosco technical school was contacted. Don Bosco is a technical school in Phnom Penh which offers two years technical education to orphans and vulnerable youth as well as out-of-school youth (Don Bosco, 2007). The target group of Don Bosco equals the group which Kamworks wants to train to become micro entrepreneurs. Don Bosco has more enrolments than places; Kamworks can give the rejected people a chance. Unfortunately an education year for Don Bosco starts in September and for this reason there were no rejected people for the pilot training, but it is good possibility for the future.

Founded trainees

After contacting other small companies and schools, where the people were too busy too, the neighborhood was investigated. Two employees of Kamworks could follow the training, because it is a good opportunity to get more theoretical knowledge about solar energy and electricity. Both of them have finished 12th degree, the 27 year old person in 1996 and the 22 year old one in 2004. Another 22 year old person wants to follow the training, because he is eager to learn more about solar systems and how to install it. He passed his 12th degree exam in 2005. Three 11th degreed men from the orphanage next to the company also wanted to follow the training. At the moment they are in 12th degree. Their ages are 23, 20 and 17. Figure shows a picture of the trainees. So everyone has finished 11th of 12th



Figure 21: Trainees

degree. But the ages range from 16 till 27, which equals the age of the target group. Besides the trainees have past their exam in different years. Unfortunately there were only men in the training group and the training materials were developed for women as well. For this reasons the target group is rather representative.

Evaluation

With the developed materials a pilot training was given from June 25 till July 7. It takes ten days. This chapter describes the experiences and observations of the trainer as well as the experiences and the opinions about the training of the trainees.

Test results

Every morning except the first two days, the trainees made a test about the content discussed the days before (figure 22). At the end of the training program a final test was made. The tests can be found in the documents for the trainer. The tests were a good evaluation for the trainer. On the basis of these tests and the exercises made during the training, the trainer knew if everybody understood the content of the training. If there were problems and or difficulties during the test, after the test the trainer explained the exercises again and sometimes gave more practice exercises. To finish the training the trainees had to pass the final test. Depending on the results of this final test, the trainees got a certificate.

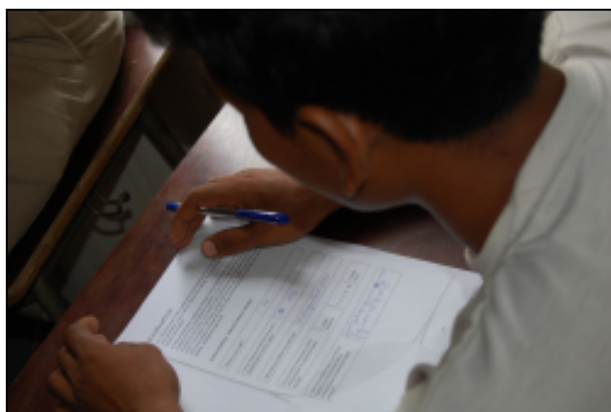


Figure 22: Making the test

Experiences trainer

Every day there were new experiences for the trainer and new problems were discovered.

The most difficult in teaching was the difference in language between the trainer and the trainees. For example the interpreter did not always copy the drama in the explanation completely or correctly, which resulted in bad understanding. Besides it was very difficult to discover the problems of the trainees,

because most of the time the trainer could not understand the trainees without help of the interpreter. Another problem during the pilot training was the difference in the level of knowledge and skills of the trainees. Some trainees really needed more time and attention for exercises and tests than other ones.

A good point was that the trainees were very eager, all the time they tried the exercises very hard and they asked a lot of questions because they really wanted to learn more.

Another positive thing was that the explanation was clear most of the time and the trainees liked to listen and think about the given information.

The planning was almost perfect, most of the time the training was finished between half past two and half past three. During a few days the training was finished too early. The extra time was used to help the trainees who experienced difficulties in the training program.

Of course there were much more experiences, these are extensively noted in appendix 3.

Experiences trainees

After finishing the training and the final test, but before knowing the test results, the trainees filled in an evaluation form. This form can be found in the documents for the trainer. The extended results of the evaluation are attached in appendix 4. Besides giving the answers to the questions on the form the trainees also gave a lot of thanks that they were able to participate in the training. They really liked the way of teaching with a lot of different explanations.

Amount of trainees and time

In the evaluation a question about the amount of trainees was asked: "There were six trainees following the training. Do you think this is a good amount or do you think more or less people can follow the training at the same moment?" The answers to this question were different. Two people answered that it were far too few people, because more people should know about solar energy and follow this special training. This was not an expected answer, but of course a nice compliment and a confirmation that the trainees thought the training was useful. The other ones said the amount of six trainees was too large, but the answer to the question 'what do you think is a good amount of people' they answered

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that six was a good amount. So the opinion of these trainees about the amount of participants is not clear after filling in the evaluation.

Every trainee answered that the time period of the training was far too short, because they wanted to learn more about solar energy. Three of the six students said that they could absorb more information in the same time period, for the other trainees the amount of information was enough for two weeks. There was an obvious relation between the level of skills and knowledge and the amount of time needed. The higher the level, the lower the amount of time needed for the training.

Content

The trainees thought the training was not too difficult or too easy, only a few parts of the training were for some trainees a bit too easy. They also thought the training was very useful and every trainee really liked the training. It was completely different for every trainee what he liked the most. One person liked the practice the most, another one the solar system and another one the calculations. There was nothing in the training they disliked and everyone liked to learn more about solar energy.

Training book

The trainees were agreeing on the opinion that the explanation in the training book was very clear, as well as the illustrations. And they thought the text and illustrations were very useful. Everybody would like to see more text and illustrations, because they simply wanted to learn more. The trainees used the text to repeat the material after finishing the training day. The pictures made it easier to understand the content of the training. Almost everybody liked colored pictures because they were clearer than black and white. The trainees really liked the appearance of the training book, because it explained everything very easily and the trainees understood everything well.

Trainer

Every trainee thought the explaining of the trainer was really clear and they liked the way of teaching, because it made them understand the content of the training. The trainees liked the practical part as well (figure 23).



Figure 23: The trainees liked the way of teaching

Language

The trainees thought the translation in to Khmer was really good and they did not think the translations were annoying, they thought it was pleasant. It did not matter for them if they were taught by a Khmer or foreigner teacher.

Tests

The trainees thought the tests were really clear. The tests also represented the training material very well, because the trainees indicated they would not been able to finish the tests otherwise. They said the level of the tests was good, not too difficult and not too easy.

Course program

All the trainees have used a course program before and the one for this training was clear for them.

Remaining

The trainees thought that a video would be helpful to understand the training, but unfortunately they could not tell exactly on what subjects it could be helpful.

Conclusion

After a period of research and development a successful pilot training was given and evaluated. This chapter shows conclusions resulted from the experiences and the evaluation.

Amount of trainees and time

The evaluation did not give a clear answer if the amount of trainees following the training was a good amount, as judged by the trainees themselves. But with six people the trainer could give much attention to everybody. Also there were enough trainees, so that they could learn from each other.

The amount of information for a two weeks training can be increased depending on the level of knowledge of the students. Some days the training was finished too early. In the remaining time trainees who experienced difficulties during the day, or the days before, could be helped.

Content

The training was not too difficult or too easy. The difficult and easy parts were alternated. For the trainees it was a very useful training with different nice things.

Training book

The explanation and the illustrations in the training book were considered very clear and the text and illustrations were found very useful. But sometimes a more extensive explanation or more text was needed. The appearance of the training book is very clear, but the pictures may be printed in color.

Trainer

The explanation of the trainer was really clear and the trainees liked the way of teaching.

Language

For the trainees it does not matter if a Khmer or an English teacher is giving the training. It is possible that a foreign teacher uses a different way of teaching from a Khmer teacher. It is less intensive for the trainer if he or

she speaks the same language as the trainees and does not need a interpreter.

Tests

The tests were considered really clear and addressed the content of the training. They were considered not too easy or too difficult.

Level of skills and knowledge of the trainees

The training was given to a pilot group of six trainees. There was a big difference in level of skills and knowledge between the trainees. For some trainees the training was a bit too easy and for another one it was heavy. The training was easier for the trainees who followed school at the moment than for the trainees who finished school many years ago.



Figure 24: Handing out the certificates

Adaptations

The trainees were very enthusiastic about the training. In the evaluation they told a lot of positive points but of course also things to improve. The trainer found things to improve too during the training and after correcting the tests. With these things in mind the pilot training was adapted. This chapter describes and explains the adapted points. The adapted training is added separately.

In chapter 1, more exercises about converting are attached, because converting seemed to be a difficult part for the trainees and they had to practice more. For this reason exercise 2.3 is also extended.

In exercise 5.4 the trainees had to measure the current at different points in a circuit. A scheme of the circuit is attached, because it was not clear for everybody where to measure the current exactly.

In chapter 5 exercises about calculation current in series and parallel connections are attached, because this seemed to be very difficult for the trainees and they really needed more practice.

Exercise 5.7 was meant to be a step by step explanation. In the questions one step was passed over. This step is attached in the new training to make the explanation clearer.

If an English speaking trainer is giving the training, he or she does not understand the Khmer translation of voltage, current and power. Therefore at the end of the sixth chapter the words are changed into symbols, because a Khmer and foreign trainer both will understand these symbols.

In chapter 7 the trainees learned what happened with the current through and the voltage over solar cells when they put them in series or parallel, by doing a practicum. There were no exercises in the training where the trainees had to use the learned information. For this reason two exercises are attached in chapter 7.

To make the information at page 43 more complete a formula about the output of a solar cell is attached.

The arrows pointing to the solar panels in chapter 7 and further are deleted, because these arrows cause misunderstandings. Some trainees thought these arrows were pointing to only one cell instead of the whole solar panel.

In the pilot training efficiency was explained very shortly. The trainees did not understand this explanation and they wanted to know more about efficiency. Therefore efficiency is explained more clearly in the adapted training and exercises are attached.

During the pilot training the trainer attached some exercises about the battery different from the training book by writing them on the board. It seemed that they were pretty difficult exercises. That is why many exercises are attached in chapter eight.

When explaining the controller, the trainees really wanted to know more about the device. So the new training shows more information about the controller.

In chapter 11 a big mistake was discovered. When calculating the minimum wire diameter or the maximum wire length, the chosen lengths of the wires going from the charge controller to the devices were split. This resulted in wires which were too long or wires which have too small wire diameters. On the new training this problem is solved by not splitting the wires.

In chapter 11 two exercises which were exactly the same were changed. In the adapted training the exercises are different.

It was difficult for the trainees to understand that the flow from the controller to the battery is a different flow than the flow from the battery to the controller. For calculations they had to choose the biggest flow between the two flows. Because this was hard for them, the trainees experienced difficulties in calculating minimum wire diameter or maximum wire length. Therefore it is explained more extensively that there are two possible flows. Some trainees experienced some difficulties by using the table in chapter 11 as well, so using the table is explained more extensively too.

Not every trainee understood exactly the formula on the bottom of page 65 in the pilot training. For that reason more explanation is attached in the new training.

In chapter 12 the trainees had to calculate the required size of the solar modules, but they did not have to choose a module. More information about choosing solar panels is attached as well as exercises about choosing solar panels. The last exercise in chapter 12 is skipped, because it was too much of the same.

Recommendations

After three months of development, execution, evaluation and improvement, training materials for future micro entrepreneurs in solar energy products were made. The pilot training was successful, the trainer was very happy with the result as well as the trainees, who took part in the training with a lot of enthusiasm. After an evaluation the training was improved, however still some aspect can be enhanced. Also some things have to be attached to the training at a later stage. This chapter describes the recommendations.

Training materials

First some extra exercises can be useful for micro entrepreneurs who take part in the training. If the trainer observes that somebody experiences many difficulties, more practice can be very useful.

If it is known which products the micro entrepreneurs have to sell, it might be important to learn them something about these products. In this training no information of specific products is given, because at the moment of development it was not known exactly which products Kamworks wants to sell in the future.

Trainees

A useful tip for Kamworks to find micro entrepreneurs is to contact Don Bosco Technical School during August, because in August the selection of Don Bosco takes place. It is possible that rejected students of Don Bosco are a possible target group for Kamworks for participation in the training program.

If Kamworks wants to train people who dropped out of school, it is smart to choose the people who dropped out a short time before starting the training and who are very motivated to start with a job. Because for this people it is easier to learn and they have the needed knowledge more readily available. If Kamworks wants to train people who were dropped out of school not a short time ago, then it is wise to only take people who were dropped out a longer time ago. It is much better and more convenient for the trainer if all trainees do have more or less the same education level.

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Appendix 1: Educational targets

Educational targets	Additional targets
Tools	
Know the function of and able to work with the following tools: <ul style="list-style-type: none"> - Crimp tool - Multi-meter - Screw driver - Tape measure - Wire cutter - Wire stripper - Pliers - Compass - Torch - Hydrometer 	Know the function of and able to work with the following tools: <ul style="list-style-type: none"> - 12 V Soldering iron - 12 V drill or hand drill - Hacksaw - Hammer - File - Shovel - Level - Extension cord - Inclinator - Funnel
Energy	
Able to distinguish different forms of energy (kinetic, electrical, thermal and light energy)	
Able to transfer one type of energy to another type	
Able to understand the following quantities and units: energy, joule, power and watt	
Able to calculate with the following formula: $P = E \div t$ and to convert the following units: Wh and kWh	
The sun	
Able to understand that the area's latitude, cloudy periods, humidity and atmospheric clarity affect the amount of solar radiation an area receives	Able to know that direct radiation comes in a straight beam and that diffuse radiation is reflected by the atmosphere and / or scattered by clouds or dust.
Able to understand that most solar radiation will be absorbed when the sunbeams strike the solar panel at a right angle	
Able to know that 'peak sun hours' are the equivalent number of hours each day when solar irradiance averages 1000 W / m^2	
Able to know that peakpower (Wp) is the amount of power a solar cell module can be expected to deliver at noon on a sunny day when it is facing directly towards the sun	
Non-electrical solar energy	
Familiar with different non-electrical solar applications (drying, cooking, etc)	
Solar electricity technology	

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Familiar with different useful electrical solar applications, household and professional	
Able to understand that it is not possible to use electrical solar energy when there is a constant high energy demand, or a demand with very high peaks	
Able to distinguish the different parts of an electrical solar system	
Able to distinguish a series and parallel connection	
Able to understand the following quantities and units: voltage, current, ampere, resistance and ohm	
Able to calculate using the following formula: $P = V \times I$	Able to calculate using the following formula: $V = I \times R$
Know that there is a difference between direct current and alternating current	
Know that solar system produce direct current and that is possible to connect DC products and that is possible to connect AC product by using a converter	
Solar panel	
Know that an array consists of solar panels and that solar panels consist of solar cells	Able to distinguish the following kinds of solar cells: <ul style="list-style-type: none"> - Monocrystalline cells - Polycrystalline cells - Amorphous cells
Able to understand that the voltage over a panel increases by adding more solar cells in series.	Know the differences between the different kinds of solar cells
Able to understand that the current through and voltage over a panel are at the highest when the sunbeams strike the solar panel at a right angle	
Able to understand that the current through and voltage over a panel decrease enormously when it is positioned in the shade or when a part of the in series connected cells are positioned in the shade	Able to understand an I-V curve and able to find the short circuit current (I_{SC}), open circuit voltage (V_{OC}) and maximum power point (P_m)
Know that the voltage over a panel decreases when the temperature of the panel increases	
Able to calculate the expected output of a solar panel by using the following formula: Production (Wh) = number of panels x peak sun hours x panel power (Wp) x efficiency	
Batteries	
Able to understand that energy can be saved in the battery and used later	Know that an un rechargeable battery can be used for one time
Know that an electrical solar energy system requires a good battery	Know that an occasional equalizing charge decreases the battery deterioration
Able to understand the following terms: state of charge (%), capacity (Ah / Wh / kWh)	

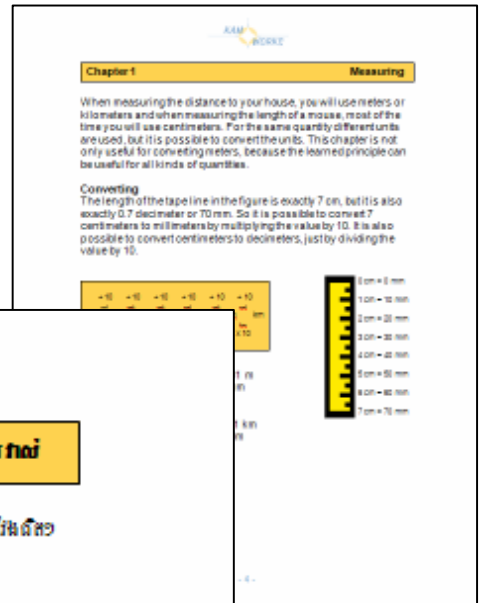
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Able to calculate with the following formulas: Q (Ah) = I * T en E (Wh) = Q * V	
Know that there are two kinds of batteries: wet and dry	
Know that dry batteries are better for an electrical solar system	
Know that wet batteries need more maintenance than dry batteries	
Know that wet batteries have to be located in well ventilated rooms	
Acquainted with self discharge.	
Able to determine the state of charge of the battery with a voltmeter	
Able to determine the state of charge with a hydrometer	
Charge controller	
Know that a charge controller manages the energy flows in an electrical solar system. so that the harvested electricity is effectively used and so that components are protected from damage	Able to choose a charge controller referring to: <ul style="list-style-type: none"> - Maximum module current - Maximum load current - Low voltage disconnect - Reconnect voltage - Battery full disconnect - Reverse polarity protection - Solar charge indicator LED - Indicator LEDs
Know that a charge controller allows the end-user to monitor the system and locate potential system problems	
Able to understand the symbols of a charge controller	
Lamps	
Know that solar systems uses PL light bulbs normally	Know that by choosing a lamp the following issues are important: <ul style="list-style-type: none"> - the direction in which the light shines - the amount of visible light a lamp produces - the amount of power a lamp requires
	Able to understand that the efficiency of the lamp depends on the light production and the power a lamp requires
	Able to understand the following unit: lumen
	Able to calculate the efficiency of the lamp with the following formula: efficiency = lm / W
	Able to distinguish different kinds of lamps
	Know the differences between the different lamps with regard to efficiency
Wiring	
Know that wiring must be chosen carefully, to make efficient use of the energy supplied by the	Know that wires exist in diameters 1.0, 1.5, 2.5, 4.0, 6.0 and 10.0 mm ²

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solar panel	
Know that solar electrical systems normally use cables of 2.5 mm ²	Know that the ground is a wire with an electrical connection to the earth and normally has two different colors
Know that the positive wire is colored red and the negative wire is colored black	
Know that a switch can be used to disconnect a part of the system	
Know that a plug can be inserted into a socket to access power for a device	
Know that fuses are devices placed in the circuit between the battery and the controller to prevent damage from high current	
Know that in a small wire little current can flow and in a thick wire more current can flow.	
Able to understand voltage drop	
Able to calculate the minimum wire diameter or maximum wire length	Able to calculate voltage drop
System design	
Able to select a suitable panel	
Able to select a suitable battery	
Able to select a suitable controller	
Installation	
Able to connect the different parts (solar panel, battery, charge controller and lamp) of an electrical solar system	
Maintenance	
Know that the electrolyte level and the state of charge have to be checked every month.	
Know that the battery needs an equalizing charge every month.	
Able to check the electrolyte level and the state of charge	
Know that a solar panel has to be cleaned every week and it has to be checked if the panel does not stand in the shade.	
Know that the connections, wiring, fuses, indicator lamps and switches have to be checked every year	
Solving problems	
Able to identify and solve simple problems	

Appendix 2: A few pages of the Khmer training



ជំពូកទី១
ការវាស់

នៅពេលដែលអ្នកវាស់ចំងាយពីផ្ទះរបស់អ្នក អ្នកនឹងវាស់ជាគីឡូម៉ែត ហើយនៅពេលអ្នកវាស់ ប្រវែងសត្វ ជាទូទៅអ្នកនឹងប្រើម៉ែត។ យើងឃើញថាប្រវែងខ្លះខ្លា យើងប្រើវាស់ផ្សេងៗគ្នា ប៉ុន្តែយើងអាច បំប្លែងវាបាន។ ជំពូកនេះ នឹងគ្រិះគែមមានសារៈប្រយោជន៍សំរាប់ការបំប្លែងម៉ែតបុណ្ណោះទេ ភាគីមានសារៈសំខាន់ក្នុងការប្រើប្រាស់លើវាស់ផ្សេងៗទៀតផងដែរ។

ការចំងែក

ប្រវែងខ្លះបន្ទាត់នៅក្នុងរូបភាពខាងលើ ៧ cm (សង់ម៉ែត) ខត់, ប៉ុន្តែភាគីស្មើ 0,៧ dm (ដេស៊ីម៉ែត) រឺ ៧០ mm (មីលីម៉ែត)។ ហេតុនេះហើយយើងអាចបំប្លែងពី សង់ម៉ែត ទៅ ដេស៊ីម៉ែតបានដោយ គុណនឹង ១០។ ភាគីអាចបំប្លែងពីសង់ម៉ែតទៅដេស៊ីម៉ែតដោយគ្រាន់តែចែកនឹង១០។

+ 10	+ 10	+ 10	+ 10	+ 10	+ 10
cm	dm	m	dam	hm	km
× 10	× 10	× 10	× 10	× 10	× 10

0 cm = 0 mm
1 cm = 10 mm
2 cm = 20 mm
3 cm = 30 mm
4 cm = 40 mm
5 cm = 50 mm
6 cm = 60 mm
7 cm = 70 mm

1 mm = 0,1 cm = 0,01 dm = 0,001 m
1 m = 10 dm = 100 cm = 1000 mm

1 m = 0.1 dam = 0,01 hm = 0,001 km
1 km = 10 hm = 100 dam = 1000m

KAM WORKS

Series and parallel circuits
At the beginning of this chapter a simple circuit was explained. Now you will look at more complex circuits. There are two types of circuits, series and parallel.

In a series circuit all the components are connected after each other. The components are connected end to end. There is just a single path for the current to flow through all of the elements.

Series circuits

In a parallel circuit the current has to take different paths to flow through all of its components.

Parallel circuit

Results shown on this page. Before ask the trainer if the circuit is correct.

21 -

KAM WORKS

សៀគ្វីសេរី និងសៀគ្វីខ្មែង

នាង មើមនី ព្រុក ចេះ សៀគ្វី តម្លាច ចាត់ ច្បាប់ រួច មក ហើយ ។ ឥឡូវ អ្នក ដឹង សិក្សា អំពី សៀគ្វី ដែល មាន ភាព ស្មុគស្មាញ វិញ ម្តង ។ វា មាន ពីរ ប្រភេទ គឺ សៀគ្វី សេរី និង សៀគ្វី ខ្មែង ។

លម្អិត ភាគ ទាំង អស់ នៃ សៀគ្វី សេរី គឺ តភ្ជាប់ គ្នា បំពេញ ដោយ កុងតឺន័រ ទាំង មូល ។ វា គ្រាន់ តែ ជា វិធី ម្យ៉ាង ដើម្បី អោយ ចរន្ត ចូល កាត់ គ្រប់ ផ្នែក ទាំង អស់ ។

សៀគ្វី សេរី

ចរន្ត សៀគ្វី ខ្មែង ត្រូវ តែ ប្រើ វិធី ផ្សេង ដើម្បី អោយ ចរន្ត ចូល កាត់ គ្រប់ ផ្នែក ទាំង អស់ ។ ផ្នែក ទាំង អស់ មិន ត្រូវ តភ្ជាប់ ទាំង មូល ទេ ឡើយ ប៉ុន្តែ គប្បី ប្រាប់ គ្នា ។

សៀគ្វី ខ្មែង

សៀគ្វី សេរី

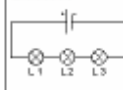
សៀគ្វី ខ្មែង

សៀគ្វី ខ្មែង

លំហាត់ 5.2
ចូរ គូស សៀគ្វី សេរី និង សៀគ្វី ខ្មែង ដែល មាន បង្ហាញ នៅ ទំព័រ ។
មុន គឺ គន្លែង ទៅ អាគុយ សូម សួរ គ្រូ គេ គឺ សៀគ្វី ត្រូវ តែ មែន ។

KAM WORKS


Exercise 6.3



Battery 12 V
I = 4 A

$V_{L1} = 2\text{ V}$
 $V_{L2} = 4\text{ V}$
 $V_{L3} = \dots\text{ V}$

$P_{L1} = \dots$
 $P_{L2} = \dots$
 $P_{L3} = \dots$



I = 3 A

$P_{L1} = 24\text{ W}$
 $P_{L2} = 15\text{ W}$
 $P_{L3} = 18\text{ W}$
 $P_{L4} = 15\text{ W}$

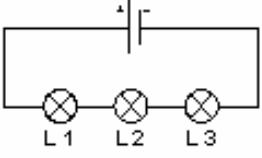
What are the voltages over the lamps?
 $V_1 = \dots$
 $V_2 = \dots$
 $V_3 = \dots$
 $V_4 = \dots$

What is the battery voltage?
 $V_{\text{battery}} = \dots\text{ V}$

What current through the battery?
..... A

KAM WORKS

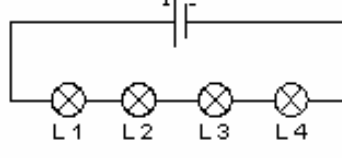
លំហាត់ 6.3



Battery 12 V
I = 4 A

$V_{L1} = 2\text{ V}$
 $V_{L2} = 4\text{ V}$
 $V_{L3} = \dots\text{ V}$

$P_{L1} = \dots$
 $P_{L2} = \dots$
 $P_{L3} = \dots$

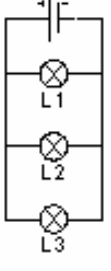


I = 3 A

$P_{L1} = 24\text{ W}$
 $P_{L2} = 15\text{ W}$
 $P_{L3} = 18\text{ W}$
 $P_{L4} = 15\text{ W}$

តើមានតំលៃវ៉ុលប៉ុន្មានលើអេឡិចត្រូល ?
 $V_1 = \dots$
 $V_2 = \dots$
 $V_3 = \dots$
 $V_4 = \dots$

តើអត្ថបទមានតំលៃវ៉ុលប៉ុន្មាន?
 $V_{\text{battery}} = \dots\text{ V}$



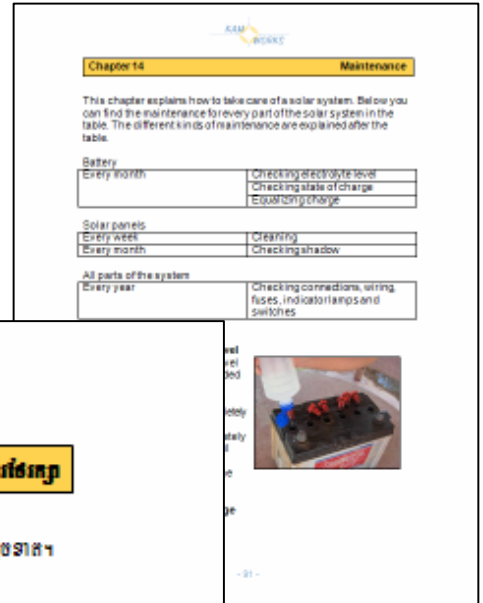
អត្ថបទ 6 V

$I_{L1} = 3\text{ A}$
 $I_{L2} = 1,5\text{ A}$
 $I_{L3} = 2\text{ A}$

$P_{L1} = \dots$
 $P_{L2} = \dots$
 $P_{L3} = \dots$

តើមានចរន្តរួមគ្នាតំលៃអត្ថបទប៉ុន្មាន?..... A

36



ជំពូកទី 14
ការថែទាំ

ជំពូកនេះពន្យល់អំពីរបៀបថែទាំរក្សាប្រព័ន្ធសូឡា និងស្ថិតស្ថេរផ្នែកផ្សេងៗទៀតនៅពេលវាមានការខូចខាត។

ការថែទាំ

នាងក្រោមអ្នកអាចឃើញអំពីការថែទាំរក្សាសំរាប់ផ្នែកផ្សេងៗនៃប្រព័ន្ធសូឡានៅក្នុងតារាង។ ភាពខុសគ្នានៃការថែទាំត្រូវបានពន្យល់នៅតារាងបន្ទាប់។

អាគុយ

រៀងរាល់ខែ	ត្រួតពិនិត្យកំរិតទឹកអាគុយ
	ត្រួតពិនិត្យសភាពសាត
	ការសាតដែលមានភាពស្មើ

បន្ទុះសូឡា

រៀងរាល់សប្តាហ៍	សំអាត
រៀងរាល់ខែ	ត្រួតពិនិត្យម្តង

ផ្នែកទាំងអស់នៃប្រព័ន្ធ

រៀងរាល់ឆ្នាំ	ត្រួតពិនិត្យបណ្តុយ ការតភ្ជាប់ ប្រសិទ្ធភាព អំពូល និងកុងតាក់។
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អាគុយ: ត្រួតពិនិត្យកំរិតទឹកអាគុយ

រាល់គោលការណ៍នៃកំរិតទឹកអាគុយត្រូវតែត្រួតពិនិត្យសូមធ្វើតាមចំនួននាងក្រោមលើស្លាកដាច់ខាត។

1. បើកទំរប់ និងត្រួតពិនិត្យថ្នាក់អាគុយតើមានទឹកពេញរឹមត់។
2. ប្រសិនបើអាគុយមានទឹកពេញត្រូវប្រុងប្រយ័ត្នសូមចាក់ទឹកបន្ថែមទាល់តែពេញ។ សូមប្រើតែទឹកអាគុយ បើទើបចុះទៅទីផ្សារខ្មែរ។

Appendix 3: Examples of certificates



Appendix 3: Experiences trainer

Monday, June 25

The pilot training started at Monday, June 25. First everybody got acquainted with each other. Everybody told his name and why he wanted to follow the training. The trainer told some things about Kamworks and the target of the training. Things about the structure of the training were explained using the course manual. The sphere of influence was very good. The trainees were a bit shy, but not too shy to talk. After acquaintance the training started with the first chapter. Soon it was clear that there was a big difference between the level of knowledge of the trainees. For some trainees the training or some parts were rather easy and some trainees found it really difficult, especially converting. For this subject they needed more exercises than printed in the training book. But it was very nice that everyone tried their best and that the trainees were willing to help each other. It was planned to discuss the exercises the day after, but the exercises were discussed in class directly after making the exercises, because everybody finished them during the day. Because of the fast discussing the teacher could assess the level of the trainees very quickly and it was possible to explain more where necessary. Another good aspect of direct correcting was the fact that the trainees knew immediately if they were right or wrong. A very nice experience was the way of teaching different kinds of solar energy. The trainer asked the trainees to draw examples of using solar energy on the black board. This resulted in some nice Cambodian pictures of the usage of solar energy (see figure 25). After the first day the trainees were very enthusiastic. The workload was not too large so the training was finished early.

Tuesday, June 26

Tuesday started with some repeating of the day before. This appeared to be very important. For some trainees everything was still clear and other trainees had forgotten some things. After repeating the electrical solar system was explained. This was clear for everybody and a game was played. Somebody told the function of an electrical part, a team member drew the electrical



Figure 25: Drawing examples of solar energy



Figure 26: Building electrical circuits



Figure 27: Making a test

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symbol and the other team member wrote down the name of the part. It was a strange way of education for the trainees, but they really liked it. Also building electrical circuits was a new experience for the trainees and they were very enthusiastic. After building simple electrical circuits, first the theory about electrical circuits was explained. This was very hard, because everything explained by the trainer has to be translated into Khmer. When the trainer used drama, it was not always copied by the interpreter. This way a lot of information was lost and it was very exhausting to explain it again for the reason the trainees did not understand because the drama was not copied. But the trainees liked the explaining, especially when they had to walk through the classroom first and after that through a small doorpost. In the classroom they could walk fast and without trouble. When everybody had to pass the doorpost, the trainees experienced a lot of resistance. After this exercise the trainees understood that devices in a electrical circuit could cause resistance like a doorpost. After the explanation of current, voltage, resistance, series and parallel circuits, the trainees built circuits and they measured voltage and current (see figure 26). Everybody was very enthusiastic, but the practice took a lot of time and the more complex systems were difficult for some trainees. The exercises about current and voltage were difficult, especially the current exercises. For this reason extra exercises were made. It was a heavy, but instructively day for the most trainees.

Wednesday, June 27

The day started by making a test about the first three chapters (see figure 27). The test took almost an hour, a bit longer than planned, and still one person was not finished. After the test the most important issues of chapter 4 and 5 were repeated and everybody knew the answers to the teacher's questions. The trainees started with chapter 6, they built different circuits and understood that the light intensity is lower in series connections than in parallel connections. The teacher explained power and after that the exercises about power were made very well. Next the trainees started with measuring on solar cells. The trainees found this very nice and were very enthusiastic. The explanation after measuring was a bit difficult, maybe because the

interpreter skipped steps in the explanation. It may be possible that the interpreter skipped some examples, while these examples were very important for understanding the knowledge. Finally the trainees understood. After the explanation the trainer asked questions about choosing solar panels. The trainees had to answer how many panels they have to choose to get a given amount of voltage and ampere. This exercise was not in the training materials and seemed to be very difficult for the trainees. During the training the marker became empty, for this reason it was more difficult to explain, because the whiteboard could not be used any longer. A paper and a pen were used for explaining, far from ideal. The last part of the day was a bit difficult, because the training book missed a clear explaining of efficiency. Some trainees did not understand the exercises, because they thought that the arrow was pointed to only one solar cell in stead of the whole panel. Therefore they thought the complete solar panel produces far more energy than meant. A trainee who finished the exercises got back his test and could correct the wrong answers. A couple trainees had made a lot of mistakes in the converting exercises, for this reason the trainer explained converting again and the trainees got extra exercises.

Thursday, June 28

The day again started with a test. Unfortunately an exercise about current had disappeared in the translated training. This time the test did not take too much time. After the test the function, the capacity and energy of the battery were explained, it was clear for everybody. In a few exercises capacity was used in stead of energy. The trainer attached some exercises different from the training book by writing them on the board. It seemed that it were pretty difficult exercises. The trainees had to calculate how long appliances can be used with a given battery capacity and they had to calculate the state of charge of a battery after using it by a given device for a given amount of hours. The subject 'state of charge' was clear and nice. After the chapter about the battery the explanation about the charge controller started. This was very clear, but the trainees wanted to learn more about the charge controller, so the trainer gave more information and the trainees liked this. The chapter

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about converting was good. This day only a beginning should be made with the wiring chapter. But because it was still two o'clock in the afternoon after finishing the first part, the chapter was almost finished this day. The exercises 11.2, 11.3 and 11.4 were a bit difficult, but after enough exercising and explaining finally everybody understood the exercises.

Saturday, June 30

Some trainees had an appointment on Friday, so the training was moved from Friday to Saturday. As usual the day started with a test, it took about half an hour. After the test, the exercises in chapter 11 were finished. This was not too difficult for the trainees, because the exercises resembled the exercises made the day before. Also the beginning of chapter 12 was not too difficult, the trainees only had to fill in some schemes. During this day some extra exercises were shown on the blackboard. With the calculated requirements the trainees had to choose one or more solar panels from a list with different panels. It was very interesting and a bit difficult for the trainees. A short time before lunch the content of this day was finished and after lunch some extra exercises (calculations with current and voltage in series and parallel connections, calculating minimum wire diameter, converting) were made by trainees who experienced more difficulties compared to the trainees who finished earlier.

Monday, July 1

The communication remained difficult, because an interpreter was needed. Sometimes the information was hard to understand for the interpreter as well, for that reason it was difficult for him to translate and explain the training. Besides he was not a teacher and missed some teaching skills. Again this day was perfectly filled and was finished around half past three. The last exercise was not made, because it was too much of the same and everybody already understood the principle. One big mistake in the training was discovered this day. In many exercises the trainees had to calculate the maximum wire length. The voltage and the power of the devices and the wire diameter were given. Some of the wires were going from the charge controller to a socket and after this to a device. Instead of calculation the length of

these two wires together, the power and voltage of the device were used for each wire and so the calculated length was too long. By calculating the minimum wire diameter the same mistake was made. Also a translation fault was discovered in the test: short circuit was literal translated to Khmer and the trainees understood this as a not very long circuit. And two exercises in chapter 12 were exactly the same.

The most difficult part this day were the exercises where the trainees had to calculate the minimum wire diameter or the maximum wire length, because it was difficult for the trainees to understand that the flow from the controller to the battery is a different flow than the flow from the battery to the controller. For calculations they had to choose the biggest flow. Also using the table was for some trainees a bit difficult.

Also today the trainees were very diligent. For this reason the difference between an automotive shallow cycle battery and a deep discharge battery was explained by the trainer too.

Tuesday, July 2

The test was made well. After the test the theory about installation was discussed, every tool needed was explained. After the explanation a solar system was installed. Everybody installed a little thing and together the trainees installed the total system. It was a very nice experience for everybody. Before installing the battery, the trainees measured the voltage over the battery, the battery was almost empty. When the system was installed completely, a red LED in the charge controller was emitting light and the charge controller was bleeping. After a few seconds the installed lamp was not emitting light any longer. The system was moved outside and positioned in the sun. The yellow LED in the charge controller was emitting light now. After a few hours the charge controller showed that the battery was charged half and the students checked this by measuring the voltage over the battery. After this the system was put inside the classroom and the day was finished. Everybody liked seeing a real solar system and working with it.

Wednesday, July 3

Today firstly the battery voltage was measured and it was found out that the voltage was lower than

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yesterday. The trainees said that it was because of self-discharge. After this there was a little problem because the training materials were not printed. The test was written on the board and everybody could make it. The 'maintenance' chapter was printed the day before, so a start was made with this chapter. The 'problem solving' chapter was a bit more difficult. A problem was drawn on the board and the trainees had to find the cause and a solution. This was a very interactive and interesting way of teaching, but it was difficult for the trainees to understand the difference between the words cause and solution. Because the training materials were not printed, the training was finished early. In the afternoon some extra exercises were practiced by trainees who experienced difficulties in the exercises.

Thursday, July 4

Today the final test was planned, but there was a translating problem and only a part of the test was translated. For this reason the test was not made today and everybody had a day off.

Friday, July 5

Today the test was finished. The test took till lunch and everybody was finished in time. The tests were corrected during lunch and everybody got enough points. One trainee made no mistakes and somebody else only two. One man passed the test narrowly. Unfortunately the evaluation form was not translated in Khmer, because the translator was too busy. The interpreter translated the questions in Khmer and the trainees could answer the questions one by one. After finishing the evaluations, Arjen handed the certificates. After handing the certificates a few pictures were made (see figure 28). The training program was finished with some coffee and tea.



Figure 28: Trainees with certificate

Appendix 4: Evaluation results

Information about the trainees								Average	Standard deviation
What is your age?		27 years	22 years	22 years	20 years	17 years	23 years		
Which degree of school have you finished and in what year?		12 grade, 1996	12 grade, 2004	12 grade, 2005	11 grade, 2007	11 grade, 2007	11 grade, 2007		
Why did you follow the training?		Because I want to know more about solar energy.	Because I think that solar systems are very important.	Because I want to know more about the solar system and the way to install it.	Because I want to know more about solar systems and I want to know how to use it.	Because I want to know more about the solar system.	Because I am curious about solar systems and electronics.		
Do you like to become a micro-entrepreneur in electrical solar energy?	1 I really dislike it / 5 I really like it	5	1	4	5	5	4	4	1.55
Can you explain why you like or dislike becoming a micro-entrepreneur in electrical solar energy?		I like it because my country needs to use it.	Because I want to become a technician about solar system and not a micro-entrepreneur.	I like it because I want to experience myself about marketing skills and selling things.	Because when I finish high school, I want to learn a science subject, Especially solar energy.	Because I want to promote this important thing to all people, so they know it and know how to use it.	I like to become a micro-entrepreneur because I want other people to learn about products which are used by energy from the sun.		
Amount of trainees and time									
There were six trainees following the training. Do you think this is a good amount or do you think more or less people can follow the training at the same moment?	1 Fewer trainees / 5 More trainees	5	5	5	1	1	2	3.17	2.04
The training took two weeks. Do you think the training took too long, too	1 Too short / 5 Too long	1	1	1	1	1	1	1	0

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short or was it okay for you?									
The training took two weeks. Do you think you can absorb more information in two weeks or provides the training too much information for two weeks?	1 I can absorb much more information / 5 Really too much information	1	3	4	1	3	1	2.17	1.33
What do you think is a good amount of trainees?		Six is enough.	Six is enough for me.	Six trainees is enough.	I want more people to know about this energy.	I want more people to participate in this special training period.	The amount of six is enough.		
Content									
Do you think the training was too difficult or to easy?	1 Too easy/ 5 Too difficult	4	3	3	3	3	4	3.33	0.52
Do you think the training is useful for somebody who is going to sell solar energy products?	1 Not useful / 5 Very useful	5	5	5	5	5	5	5	0
Did you like the training	1 I really disliked it / 5 I really liked it	5	5	5	5	5	5	5	0
What were the most difficult and the second most difficult part of the training for you?		Calculations	-	-	Practice	-	The training was a bit tough for me.		
What were the easiest and the second easiest part of the training for you?		-	Installing the solar system.	-	Theory.	I understand all the lessons.	First part, the other parts were not too easy.		
Can you tell the three things you liked the most?		Solar system, connection of the controller, charging the battery.	Calculations about energy, installing the solar system, calculations	Solar system, lamp system and explaining DC and AC.	Practice, theory and tests.	Connection the solar system, series connections and materials.	Installation, solar devices and maintaining.		
Can you tell the three things you disliked the most?		-	-	-	-	-	-		

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What have you learned from this training?		Understanding the multi-meter.	Knowledge about the inverter and the controller and other solar devices.	How to install the solar system and how to connect wires.	Theory, how to use, more practice and how to look after solar system.	I learned about the solar system, how to install it and about the solar materials. I know how to use a solar system and I can calculate how many panels are needed for a given use.	How to install and maintain the system. Maintain the battery and other useful things		
Are there other things about solar energy you would like to learn?		I like to learn more.	I like to learn more.	I like to learn more.	I like to learn more.		I like to learn more.		
Manual									
Are the explanations clear in the manual?	1 Really unclear / 5 Really clear	4	5	5	5	5	4	4.67	0.52
Are the illustrations clear in the manual?	1 Really unclear / 5 Really clear	5	5	5	5	5	5	5	0
Was the text in the manual useful for understanding the training?	1 Really not useful / 5 Really useful	5	5	5	5	5	5	5	0
Would you like more or less text in the manual?	1 Less text / 5 More text	5	5	5	5	5	5	5	0
Were the illustrations useful for understanding the training?	1 Really not useful / 5 Really useful	5	5	5	5	5	5	5	0
Would you like to have more or less illustrations in the manual	1 Less illustrations / 5 More illustrations	5	5	4	5	5	5	4.83	0.41
The illustrations in the book were just white and black. Would you like the pictures to be in color?	1 Colored pictures are not necessary / 5 I would like colored pictures	5	1	5	5	5	5	4.33	1.63
Did you like the appearance of the manual?	1 I really like do not like it / 5 I really like it	5	1	4	5	5	5	4.17	1.6

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If you experienced unclear explanations or illustrations, please mention where these are located in the training and why these were unclear		Clear	Clear	Clear	Clear	Clear	Clear		
If you need more text in the manual, can you tell on what issues?		Use of the solar system.	Installation		Theory and how to practice.				
Can you tell why you would like more or less text and or illustrations?		I want to understand it clearly and I want to study it more.	I want to know how to install the solar system correctly.	Because I want to know it clear.	I need text and illustrations because it can make more knowledge.	Because I want to know more.	I want to read the text and the illustrations assist me to comprehend.		
If you prefer colored pictures to black and white pictures, can you tell why?		Colored pictures are clearer and it is easier to understand the pictures.		Because colored pictures are clearer and easier to study.	Colored pictures are clearer.	Because it is easier to understand the pictures.	Because the colored picture are clearer.		
If you would like to see more illustrations in the manual, can you tell what kind of illustrations (graphs, pictures, drawings)?		Graphs	Energy	Graphs	Drawings	Graphs	Pictures		
Can you explain why you like or dislike the appearance of the manual?		I like it because it is very clear and easy to understand.	I like it because the explanations are clear.	Because it describes the solar system clearly.	The manual is easy to understand.	Because it explains me more about the solar system and how to install it.	Because it clearly describes how to install the solar system.		
Trainer									
Were the explanations of the trainer clear	1 Really unclear / 5 Really clear	5	5	5	5	5	5	5	0
Did you like the way of teaching?	1 I really disliked it / 5 I really liked it	5	5	5	5	5	5	5	0
Can you tell why it was clear or unclear and which parts of the training were		-	-	-	-	-	-		

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unclear, if there were any?									
Can you tell why you liked or disliked the way of teaching?		Makes it easy to understand.	Makes it easy to understand.	Makes it easy to understand.	Many experiments.	Makes it easy to understand.	Good and clear explanation.		
Language									
Were the translations annoying or pleasant during the training?	1 Really annoying / 5 Really pleasant	5	5	4	5	5	5	4.83	0.41
Do you prefer a Khmer speaking teacher?	1 Really do not prefer / 5 Really prefer	3	3	2	3	5	3	3.17	0.98
Tests									
Did the questions of the tests address the content of the training?	1 Not addressed at all / 5 addressed very good	5	5	4	5	5	5	4.83	0.41
Where the questions clear?	1 Really unclear / 5 Really clear	5	3	4	5	5	5	4.5	0.84
Where the tests too easy or too difficult?	1 Really to easy / 5 Really to difficult	3	3	3	3	3	3	3	0
Can you tell why the questions addressed the content of the training good or bad?		Were about the content, because if they were not I could not make it.	Because I want to study more about calculations .	Were about the content, because if they were not I could not make it.	Were about the content, because if they were not I could not make it.	Because the test were about the lessons they were taught	Were about the content, because if they were not I could not make it.		
If there were unclear questions, can you tell which questions and why?		-	Some questions were unclear because the translator is not a technician.	-	-	-	-		
If the tests were too easy or too difficult, can you tell why?		-	-	-	-	-	-		
Course manual									
Have you ever used a course manual before?		Yes	Yes	Yes	Yes	Yes	Yes		

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Was the course manual clear for you?	1 Really unclear / 5 Really clear	5	5	4	5	5	5	4.83	0.41
Remaining									
Would a video be helpful to understand the training?	1 Really not helpful / 5 Really helpful	5	5	5	5	5	5	5	0
If you think a video will be helpful, on what subject?		Physic and others.		A video related to other skill subjects, especially skills in technique.	Science	Physic	Technical skills.		