“Design of educational material
about solar energy and a solar home system for rural Cambodia”

By Yvette Moekotte
12th of December 2008

University of Twente
Enschede - The Netherlands

Universiteit Twente
First tutor: dr. ir. mba A. van den Boomgaard
Second tutor: prof. dr. ir. A.O. Eger

KAM WORKS PICO SOL

Kamworks / Pico Sol
Tutor: J. Verschelling
Tutor: H. de Gooijer

Summary

Introduction

This report covers the process of the design of educational material about solar energy and solar home systems. This was a bachelor graduation project of the University Twente performed for Kamworks, a Cambodian company in photovoltaics. This summary covers the problem from which this project originated, an analysis the factors that influence this project and the final design of the educational material.

The problem

Electricity through an electricity grid is in Cambodia only available in and around the major cities. In the rural area's people use mainly car batteries to meet their electricity demand. Kamworks tries to improve the energy situation of Cambodians living in the rural areas by putting the solar home system on the market. This is a small system that can supply a Cambodian family of electricity through solar energy. But Kamworks experienced that the rural Cambodians don't understand solar energy. Therefore they initiated this project to develop educational material about solar home systems.

Analysis

In order to design for a totally different culture an analysis of the Cambodian culture was performed. Several results from this analysis were important for the further process. First of all there is a high illiteracy rate in Cambodia, what puts a limit on the use of text in the materials. Second, social status is very important for Cambodians and can also become higher by owning luxury products, which a solar home system can be considered. Third, there is the restrain that Cambodians are not used to think and buy for the long term, what is necessary to see the benefits of a solar home system.

Currently Cambodians living in the rural areas use several energy sources for their household. According to an analysis of the energy situation in Cambodia the main concurrent of the solar home system is the car battery. For Cambodians this seems to be the cheapest option, but on the long term a solar home system is cheaper and requires far less maintenance.

Although Cambodia is an almost perfect country to use solar energy, this technology is not widely used through the country. In interviews almost no one knows what it is or has ever seen it. This combined with the high illiteracy rate requires a very basic explanation of solar energy for rural Cambodians. Important is to attract people into the shops so the shopkeeper can introduce this technology to the people.

The most important characteristics of acceptance of innovations in Cambodia are price, quality and fulfillment of obvious needs. These must be positively represented on the educational material. This is validated by expert interviews who mention the same characteristics together with the a good explanation of the good use of household appliances when using a solar home system.

Design

The final design based the requirements that originated from the analysis is a information display that is placed in the Kamunasal shop. The display has an intergrated television screen that shows an animation of how a solar home systems works and a promotional video. On both sides of the television screen are three posters that cover all the main subjects on solar energy and a solar home system; usage, working, cheap, no charging, easy and quality. This all together is designed in the same style as the solar shop.

Terms and Abbreviations

AC
Alternating current

A
Ampere (unit of electrical current)

Ah
Ampere hour (unit of electric charge)

CIA
Central Intelligence Agency

CRCD
Cambodian Research Centre of Development

CPP
Cambodian People's Party

DC
Direct currentirect current

GDP
Gross Domestic Product

FUNCINPEC
National United Front for an Independent, Neutral, Peaceful, and Cooperative Cambodia

ITIM international
Culture and Management Consultancy based on the work of Geert Hofstede

KOSAN-engineering
Engineering company in Cambodia

MDF
Medium-density fibreboard

MIME
Ministry of Industry Mines and Energy

N-layer
Negative layer (in a solar cell)

NGO
Non-governmental organization

NRP
Norodom Ranariddh Party

P-layer
Positive layer (in a solar cell)

UNPD
United Nations Development Programme

SHS
Solar Home System

SRP
Sam Rangsi Party

V
Volt

W
Watt (unit of electrical power)

Wh
Watt hour (unit of energy)

Wp
Watt piek

Preface

This report describes the process of my bachelor assignment for Industrial Design Engineering at the University of Twente. I choose not to perform this assignment in the Netherlands, but in an Asian culture. My former experiences in Malaysia for my minor project made me so enthusiastic that I wanted to take this next opportunity to go to Asia. Over a year before the start of this project, I already heard of the assignments in Sre Ampil, Cambodia. Fortunately when I was ready for my bachelor assignment, I was able to get the most interesting project (according to me of course!) of all projects offered by Kamworks!
The first month I performed an analysis in the Netherlands, but after these four weeks I was finally able to go and see the real thing in Cambodia. I learned far more from this whole expierence than just performing an individual project in a company. It was truly an amazing experience to live between the rural Cambodians at the solar Campus. Experiencing another culture from so close puts everything that is normal in the Netherlands in perspective. Practicing my English, having Cambodian friends, meeting foreign students and living under primitive circumstances are just a number of things that made this assignment the most interesting one of my bachelor. Of course this wasn't always easy, but all the support from people in the Netherlands as well as in Cambodia made it worthwhile.

Therefore, I would like to thank all the people that helped me in any way making this assignment possible. First of all this is Thonie van den Boomgaard, who helped me with all my questions along the way, for what I am very grateful. Before and after my stay in Cambodia I could always rely on Henry de Gooijer, who puts an incredible amount of energy in helping all the students in Cambodia. He has been a real motivator for me several times! During my stay Jeroen Verschelling helped me with all my questions concerning the project, which I thank him for. Then of course Leap and Pip, who helped me get introduced into the for me sometimes very complicated Cambodian culture. All the students at the solar campus made the stay fun and even very educational, because of the good cooperation. And of course I would have never been able to do this without the support of my family and friends in the Netherlands, who I thank for all the support from a dazzling distance of 11.000 kilometers!

Some of my friends in Cambodia

Table of Contents

Chapter one

"Scope of the project"

1.Scope of the project

Introduction

This first chapter introduces the reader into the assignment. All the basic information that is needed to understand this report is given in this chapter. The parties involved are described, as well as the description of the project. After this the structure of the report is given, so the process becomes clearer to the reader. Final, the used terms and abbreviations are explained.

1.1 Involved parties

Pico Sol

The charity foundation Pico Sol is founded in 1999 by several volunteers with a specific interest in solar technology. The goal of Pico Sol is to bring (knowledge of) solar energy to people living in the rural areas of developing countries. The main difference with other NGO's or foundations in developing countries is that they do not only give financial support, but are also able to give technical aid.
In 2006 Pico Sol started a new company in Cambodia named "Kamworks". Nowadays Kamworks is a totally self-sustaining company.

Kamworks

One of the concerned parties is Kamworks, the company that composed the assignment. Kamworks is a solar company that is established to provide affordable energy systems in Cambodia in order to contribute to a sustainable development of this country. Kamworks has been established as a spin-off of five years co-operation between the Dutch charity Pico Sol and the Khmer Foundation for Justice, Peace and Development.
Kamworks works on its mission with 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 co-operates with the Dutch solar system integrator Ecostream.

Kamunasal

Kamunasal is the new daughter company of Kamworks. Because the core business of Kamworks lies in the professional sector a new brand was initiated to release products for the consumer market. The Kamunasal brand is not yet established in the Cambodian consumer market. The main products of the Kamunasal shops are the Angkor light and a Solar Home System. The Angkor light is a high quality light that works on solar energy. A Solar Home System is a small solar panel with a battery that can supply a family of clean and easy energy.
The final display that will be designed in this project will be placed in the Kamunasal shops to inform the target group about the solar home systems and solar energy.
The shops are a project of Kamworks that is sponsored by the World Bank. At the moment there are two placed shops in the area of Sre Ampil on small markets. The goal is to place at least 8 shops in the near future. The shops that are placed at the moment aren't the final versions of the shop. These shops are a test serie for further development. Although this is not the final interior of the shop, the container that is used as a shop will be used in future designs as well. Because the new design of the shop is made at this very moment the options for placing the information display are still open. The most likely option is that the information display will be on one of the two side walls, because the back wall will probably be used for clear branding and displaying products.
A shop observation of Kirsten Rijke (2008) showed that on a average 2 to 3 costumers come to a Kamworks shop every day. These costumers are mostly male and at least 40 years of age. Because the illiteracy rate is often higher under the elderly, there is a good chance that a large part of the target group cannot read. Their purpose of coming to the shop is mostly curiosity and not the intention to buy something. The costumers almost never really enter the shop, but stay in front of the shop watching the displaying cabinet. The shop owners think that the following aspects of a product and sales are important:

- The price of the product
- The quality of the product
- It is important to show the customer how to use it
- It is important for the customer to try out the product
- Start a conversation with the customer and invite them in
- They don't like products with a lot of functions

Opening of the Kamunasal shop

1.2 Description of the project

The new daughter brand of Kamworks, named Kamunasal has already placed two shops to distribute the solar products to Cambodians living in the rural area's. Six more shops are planned to be placed in this year. The experience of the people involved in Kamworks activities is that most potential clients don't understand what solar energy is. This gives disappointing sales numbers.
To sell one of the main products of the Kamunasal brand, the solar home system, it is essential that people understand what solar energy is. The goal of this project is to design educational information about solar energy for potential clients of the solar home system.

Chapter two

"Cultural analysis of Cambodia"

2.Cultural Analysis of Cambodia

Introduction

The difficulty of this project is that it is executed in a different culture. Therefore the research on the target group is far more extensive then usual. In order to relate the project more with the target group an analysis of the Cambodian culture is performed. This is divided in three different sections.

The first section describes the general characteristics of the Cambodian culture, naming; geography, people, political and economy.

The second section emphasizes the different components of a culture, stated by Ball & McCulloch et al (Ball et al., 2008). These are called the sociocultural forces, naming; Aesthetics, Attitudes & Beliefs, Religion, Material Culture, Education, Language, Societal organization, Political structure and legal characteristics.

In the final section the cultural dimensions of Geert Hofstede (Ball et al., 2008) will be explored. These dimensions are; Power distance, Individualism, Masculinity, Uncertainty Avoidance, Long term orientation.

This all together gives a very extensive description of the Cambodian culture. At first it might seem that a lot of information is not very useful for this specific project. But without understanding the culture, it is almost impossible to have success designing something for the people in it. In the last two sections of this chapter the connection between the cultural information and the project is given, in order to keep the focus on the project.

2.1 Generals of Cambodia

(Ray, 2005), https://www.cia.gov/library/publications/the-world-factbook/geos/cb.html (visited 1 April 2008)

Geography

The Kingdom of Cambodia is a 180,000 sq km country in Southeast Asia. Cambodia shares it borders with Vietnam, Loas and Thailand and the Gulf of Thailand. The climate can be described as a tropical one with a dry season from December to April with temperatures around 40°C and monsoon from May to November with temperatures around 30°C. The terrain in Cambodia is mostly flat plains with mountains in the southwest and north. The east and western part of Cambodia is divided by the Mekong River and the Tonle Sap river. These two rivers join just north from Phnom Penh.

Fig 1. Map of Cambodia

People

The total population in Cambodia is estimated at 14 million people. The nationality of Cambodia is Khmer that represents 90% of the population. The largest minorities in Cambodia are Vietnamese and Chinese. The largest group of the population, around 95%, is Buddhist. The illiteracy rate was over 26% in 2004. Because of the war more than 50% of the people is under 21 years old.

Political

The government type of Cambodia is a multiparty democracy under a constitutional monarchy. The most important political parties are the CCP, FUNCINPEC, NRP and SRP. Since 29 October 2004 the king of Cambodia is King Norodom SIHAMONI. Cambodia is divided into 20 provinces and 4 municipalities. The capital is the city Phnom Penh, located in central south Cambodia.

Fig. 2 Respectively: The King (2008), The Prime Minister (2008) and a popular second job; bus driver

Cambodia has been through a rough time politically from 1975 to 1979. In this period the Khmer Rouge ruled the country and they had taken power with a lot of violence. The Khmer Rouge is a part of the communistic party of Kampuchea (the former name of Cambodia). They imposed a strict policy in Cambodia, in line with the communistic way of thinking. This resulted in the killings of by estimation 1.5 million people. This happened in great numbers by assassinations, death by exhaustion of working in the forced labor camps or death by starvation because of the food distribution policy. This cruel way of leading the country left its scars for the people and the culture.

Economy

Cambodia is a developing country, with a slowly growing economy. The gross domestic product per capita is was $1,900 dollar in 2007. This is just a fraction of the GDP per capita of the Netherlands, which was $39,000 in 2007. On the rankinglist of the CIA this results in a 17th place for the Netherlands and a 185th place for Cambodia of the 229 total listed countries.

The most important sectors for Cambodia are agriculture (31%), industry (26%) and services (43%). Although agriculture only supports 31% of the GDP per sector, about 75% of the population is active in this sector. The total labour force is estimated at 7 million and the unemployment rate at 2,5%. Outstanding is that 35% of the population lives under the poverty line.
These numbers have to be treated with care. Experiences tell that many of the Cambodians have more than one job and do not pay taxes over their second or even third jobs. This makes it very hard to analyze the financial situation of the Cambodians. Expected is that the Cambodians that are registered as a family living under the poverty line have more income than officially reported to the government, because of these extra jobs.

2.2 Sociocultural forces

Aesthetics (North, 2006)

- *Arts*

Many of Cambodian arts was destroyed by the Khmer Rouge. "Despite this, Cambodia is witnessing a resurgence of traditional arts and a growing interest in experimentation in modern arts and cross-cultural fusion" according to Ray (Ray, 2005, page 50). There are only a few pieces of ancient arts left. One of the most important pieces that are left is the Angkor temple complex. This has become the national symbol of Cambodia and is even represented in the national flag.

- *Literature*

Literature is a rare thing in Cambodia and often linked with Buddhism or myth and legend. Many scriptures are in ancient languages. The themes are often values of family ant faith and obedience to authority.
In the past literature was in particular in the hands of the higher educated that were able to read. With the destructions of the war both higher educated and literature disappeared in great numbers. What is left are mainly ancient stories that are told mouth to mouth.

- *Performance arts*

The traditional art of dance also suffered a great deal in the Khmer Rouge period, because there was a ban for all arts in this period. But by opening the University of Fine Arts in 1981, the training of dance student resumed. Where traditional dance used to be only performed by females, nowadays more men participate in traditional dance.
Music plays a big role in the Cambodian culture. Music has its origin in the religious sphere. Here music was part of blessing ceremonies, wedding and funeral ceremonies etc. The most traditional style of ceremonie music is the *areak ka*, an ensemble that performs at weddings, explains Ray in the Lonely Planet (Ray, 2005, page 51)
After the rule of Pol Pot many musicians ended up in the US, where they mixed Cambodian style music with US influences. This style has been popular since it was brought back to Cambodia.

- *Festivals*

The Cambodians don't need a good reason to start a party, they have many festival days. These originated from political or religious reasons. There are three occasions in a Cambodian year to celebrate a new year, The Gregorian New Year (1st of Janary), the Chinese New Year (January or February) and the Cambodian New Year (mid-April). The Gregorian New Year is least important for Cambodians. A way traditional way of celebrating the Cambodian New Year is to throw water at each other.
A typical Cambodian holiday is Bonn Pchem Ben that takes places around September or October and can be translated as Ancestor Day. This is celebrated with events like buffalo races through villages, wrestling matches and boat races.
The start of the ploughing season is a reason for a national holiday as well. This is called Bonn Chroat Preah Nongkoal and takes place in May. This season is started with a prediction of the weather and harvest for the coming season.

Fig 3. Respectively: Cambodian dancers and the opening of the ploughing season

Relation of sociocultural forces to the project

In an earlier project the national symbol Angkor was used in a product name. Using this symbol of national pride for products or services is common in Cambodia. It appears to create a trustworthy reputation towards potential clients. This might also be something useful for this project to establish the new brand and unknown products of Kamunasal
Music plays an important role in the life of Cambodians. In the rural areas music can be heard everywhere. This usually is different music from the music that is played in the cities. This can be a powerful marketing tool for promotion of the Solar Home

System. Kamworks has plans to create a song to explain solar energy.
Around all the big national festivals a lot of money is spend for gifts to family and friends. It could be useful to promote the solar home system as a potential gift for families around the holidays.

Attitudes & Beliefs (North, 2006)

Many attitudes in Cambodia are a result of Buddhism or ancient beliefs and practices. For example their days in the week are named after gods of various religions. In some parts of Cambodia the days of the week are also linked to a color, totally independent from te naming of the days. Each of these colors carries superstitious meaning. Cambodian women sometimes were clothes in the color of the day to enhance the superstitious meaning of the color of that day.
Like in many cultures the three stages of life, birth, wedding and funeral, are celebrated with ceremonies. Different to the Dutch way of celebrating these stages these ceremonies can take up to several days, although the pressure of today's busy life has decreased the extent of ceremonies. But not only the important stages of life are celebrated by a ceremony. Many ceremonies are practiced, for example a ceremony that blesses the workspace.
The attitude of Cambodians towards work is experienced by Westerns as similar to the working culture in South-East Asia. In Western terminology the working culture is laid-back, non competitive and not really ambitious. Inferiors in the workplace are inclined to endorse what the boss want, or what they think the boss wants. They don't give much input and when done it is often not appreciated by the superior.

Relation of attitudes & beliefs to the project

The Asian work-culture requires some adjustments from the Dutch approach of this project. There is a very realistic change that many activities will not go as planned. This is especially important information for the interviews that are executed in a later stadium of the project.

Religion (North, 2006)

The majority of the Cambodians are Buddhists, the estimations are around 95 %. Because this is such a great part of the Cambodian culture an introduction to this religion is given.
There are two main forms of Buddhism, the Mahayana and the Theravada. This last type is the form that is adopted in Cambodia. Buddhism is an extraordinary religion. Many people believe that Buddhism is not only a religion but a state of mind.
The ultimate goal of Buddhist is to attain nirvana. This means that they reach the ultimate state of being by achieving complete detachment from the world. A Buddhist can reach this state by performing good deeds, also called merit. This can be done by supporting the monk hood, praying, chanting, worshipping the Buddha and living an ethical live. These activities play a big role in the Buddhist lifestyle, because this determines the karma of the Buddhist. This can be explained as the force of existence that determines a person's destiny.
The idea of earning merit and karma is based on the idea that good and bad deeds influence a next life. Buddhists believe that everything reincarnates after death into some form to live another live. This endless cycle of lives can only be ended by reaching enlightenment or nirvana. This can be considered as the opposite of materialism.
A notable difference between Buddhism and many other religions is that it aspires harmony and tolerance and acceptance of other, including non-believers. The only thing they expect is mutual respect for their religion. It is even allowed for a Buddhist to practice other religions than exclusively Buddhism. This harmonious way of life was brutally interrupted by the period of the Khmer Rouge. They banned all religion and didn't share the ideology of Buddhism that was supported by the majority of the Cambodians.
The Buddhist lifestyle in Cambodia has consequences in every day life. Great acceptance of any misfortune, great or small, in their life is reached by the belief in karma. This results in a harmonious society. The Western point of view on this great acceptance is that it suppresses ambition. Also earning merit influences daily life. This can be for example by praying or helping the needy.
One other important aspect of the Buddhist religion that has to be explained are the monks. There are only male monks, these men have dedicated a part of their live to Buddhism. Many young men become a monk for a short period of time (around six months), this is seen as a part of their upbringing. They live in the temples and practice meditation. Besides practicing religion itself, the monkshood offers other advantages, for example education. Examples of the sacrifices they have to make are not to eat past midday, not to drink alcohol and avoid any non religious music. Monks are treated with a great deal of respect, therefore there are srict protocols for interaction with monks. For example, it is important not to have any physical contact with the opposite sex.

Relation of religion to the project

Because Buddhism is not only a religion but also plays a very important role in the day to day life of Cambodians it is important that there is at least basic knowledge about Buddhism. This to make sure that the final design strokes with the basics of this religion. When there is interaction with Cambodians for this project this information is useful, for example during interviews.

Fig 4. Respectively: Young Cambodian monks and a monk using modern technology

Material culture (Ray, 2005)

Keeping your status high by not losing face is the key to success in Asia, and Cambodia is no exception. Keeping face is accomplished by throwing big celebrating ceremonies and throwing money around like it is water. This often can be ruining for the family, but this is far less important than losing face. After reading about the vision of Buddhist to reach enlightenment by living a non materialistic lifestyle, this all might sound odd. But losing face and prestige is so important for Cambodians that the money spending in public has sneaked into the culture as in many Asian countries.

The younger generation is slowly changing the lifestyle in Cambodia. The young watch MTV and soaps, dress as they like, go out and date who they want. With this new lifestyle the material status becomes more important.

Relation of material culture to the project

A solar home system is a big investment and Cambodians rather don't spend big amounts of money when there is a cheaper but in the long term more expensive alternative. But they are willing to spend extra money when this can improve their status. Presenting a solar home system as a luxury product can be one of the convincing reasons for Cambodians to make this investment, because it improves their social status.

Education (North, 2006), (Heerdink, 2007)

As already mentioned before, the illiteracy rate in Cambodia is very high. It is actually one of the lowest rates in whole Asia. This already gives an idea of the situation in Cambodia concerning education. Unfortunately the history of Cambodia plays a big role. During the French Colonial period (1864 – 1953) education wasn't a priority. When the French left the education began to develop; school and universities were established. But during the Khmer Rouge period (1975 – 1979) almost all these just established learning institutions were destroyed. After this period the education level slowly began to grow, but Cambodia still has a long way to go.

The first level of education in Cambodia is kindergarten where they attend to at the age of three and with the duration of three years. At the age of six the children can go to primary school and this takes six years. Going to primary school is free, but only 90% of the children go. The courses in primary school include calculating, writing and reading. After primary school there is the option of going to secondary school. This exists out of two stages; lower secondary school and upper secondary school. These two stages both take 3 years to finish. Going to secondary school is very rare among Cambodian children. Only 26% go to lower secondary school and 9% go to upper secondary school. Although this all may seem concerning, the level of education is growing every year.

The way of teaching in Cambodia is style that is used in many Asian countries. The teachers enjoy a high status. This in combination with the Buddhist values makes the education very passive. Everything the teacher says is accepted as the total truth and cannot be undermined. In practice this means that the teacher is mostly talking and there is no interaction between teacher and student. Because of the lack of practical courses they cannot relate any information they receive in class to real life.

Fig. 5 Cambodian class

Fig. 6 The same word in Khmer and English

Relation of education to the project

The illiteracy of the Cambodians can be an obstacle for this project. It is undesirable to explain the unknown principle of solar energy by text. Other options for explaining this to the potential clients must be researched.

Because of the way of teaching in Cambodia the Cambodians aren't used to a lot of interaction in a learning process. More research in presenting new information and innovations in a developing country must be performed to connect with the target group.

Language (North, 2006)

"The national language of Cambodia is Khmer, spoken by about 95 per cent of the population", as stated by North (North, 2005, p. 179). The Khmer alphabet exists out of 33 consonants and 23 vowels. Cambodian's tend to be very proud of their language and try to maintain their unique language. But as in most languages words from other languages are adopted. In the Cambodian language this contribution to the language is mostly from English, French, Malay, Vietnamese, Thai and Chinese. The French language was the second language in Cambodia for many decades after the Colonial period. Nowadays the second languages vary between different parts of Cambodia. The regions that share a border adopt the language of the neighboring country. For the west this is Thai, for the East this is Vietnamese. English is also an upcoming language, because many Cambodian see knowledge of the English language as a change of a better future. In the larger cities and around tourist sights English is more and better spoken than in rural areas.

Then there is the, for outsiders, very difficult system of unspoken language. Although Cambodians do not expect visitors to fully understand their way of communication it is certainly interesting for this assignment to explore.

The Buddhist religion that is practiced in Cambodia has a system of social status established by birthright. Besides the status by birthright, there is also the status that is determined by factors from this life. This is a mixture of age, occupation and social advantage. This pecking order is common for Asia. Older people are respected by the younger ones and educated as well as rich people earn respect. And skin color is also influencing the social status, the lighter the skin the more superior.

Besides the social order in groups, there is also an order of status for different parts of the human body. The status of the limbs generally corresponds with their height. The head is highest and receives the most respect. It not appreciated if the head it touched. The feet on the other hand are considered the lowest part of the body, especially the foot soles.

Another aspect of the unspoken language are the things the Cambodians don't say. This might seem strange, but this is a common way of dealing with situations in Asia. The most important rule in communication in Cambodia is to stay calm and stay polite. Conflicts must be avoided at any time, because loosing calmness is equal to losing face. This results in very polite but not always truthful answers to questions. Body language is also important in Cambodia, or maybe more the absence of body language. Cambodians are very modest and tend not to use many gestures or so. They use the polite bow "sompeyar" when they meet, equivalent to the Thai "wai".

Relation of language to the project

This information is especially useful for interviews. Because of many possible pitfalls of the unspoken language, it is important to assure good Cambodian guidance during interviews from the translator. The "nodding culture" in Asia makes it very hard to get to the bottom of things and this could influence the project in a wrong way.

Societal organization (North, 2006)

The family plays an important role in the Cambodian society. "The concept of family in Cambodia runs wider than the immediate family of fathers, mothers, sons and daughters. It includes aunts, uncles, cousins and second cousins. Marriage between distant members of the same family is common and even encouraged", says Peter North (North, 2006, p. 68) Often several generations live in the same house together. Because there is no social welfare provided by the state, this is taken care of by the family. Women are responsible for the household finances and the stronger family members take care of the weaker and younger family members. Women also go to work, but often cover less high positions.

Relation of societal organization to the project

An emphasis on the value of a solar home system for the whole family could be a strong marketing tool to connect with the potential clients. This should not be only directed to the head of the family, who is most likely to be a man. The women are responsible for the finances of the family and play an important part in spending the household money.

Political structure and legal characteristics (North, 2006)

As mentioned before, Cambodia is a multiparty democracy under a constitutional monarchy. As in many Asian countries corruption is interwoven in the political and legal structure as well as bureaucracy. High positions in politics are often only available through connections or are bought off.

2.3 Cultural dimensions of Cambodia

"We tend to have a human instinct that 'deep inside' all people are the same - but they are not. Therefore, if we go into another country and make decisions based on how we operate in our own home country - the chances are we'll make some very bad decisions." (Geert Hofstede, http://www.geert-hofstede.com/index.shtml, visited 31 of March)

Geert Hofstede conducted a study on cultural dimensions. These cultural dimensions describe how values in the workplace are influenced by the culture of a country. To avoid making bad decisions the different elements of culture defined by Geert

Hofstede will be described. Unfortunately, there is no data on cultural dimensions of Cambodia. That is why the average scores and scores of other Asian countries is used. The countries that Hofstede analyzed and are geographically near to Cambodia are Thailand, Philippines, Indonesia and Malaysia. Although these countries are all located near Cambodia, Thailand gives the most valuable information, because religion has a great influence on the cultural dimensions. Buddhism is the main religion in Thailand with a percentage of 94.6 Buddhists. Indonesia and Malaysia are both heavily Muslim oriented countries, so they don't match with the profile of Cambodia. The Muslim religion has a great influence on the power distance and uncertainty avoidance index of a country. The Philippines are mainly Catholic and therefore also not a good match with Cambodia's profile.
In figure 7 and 8 the indexes of the cultural dimension of respectively Thailand and Asian's average are displayed. The Asian average of cultural dimensions is based on research in the following countries: China, Hong Kong, Indonesia, Japan, Malaysia, South Korea, Taiwan and Thailand. From this data the most likely outcome of indexes for Cambodia is extracted.
First, the five cultural dimensions of Geert Hofstede will be explained below. After the explanation, the score that is most likely for Cambodia and why will be discussed.

Power distance

Power distance is explained by ITIM international (http://www.geert-hofstede.com, visited 1 april) as the extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally. Thailand's score (64) on the Power distance index is a little lower than Asian average (71). It is likely that Cambodia has a power distance somewhere near the score's of Thailand an Asia. According to the ITIM (http://www.geert-hofstede.com, visited 1 april) a high score on Power distance indicative of a high level of inequality of power and wealth within the society. As described in the cultural components of Ball et McCollough (Ball et al., 2008), in Cambodia the Buddhist religion divides the population in different social classes by birth-right. Besides that, there is also a unwritten system of social order determined by wealth, skin color, occupation etc. This makes Cambodia a society with high inequality of power and wealth.

Relation to the project of power distance

The powerdistance of Hofstede gives somewhat the same conclusions for this project as the cultural dimension "Material Culture" of Ball et McCulloch. Status is everything in Cambodia and there are a million ways to improve or lower your status. Products can also improve status and so could a solar home system.

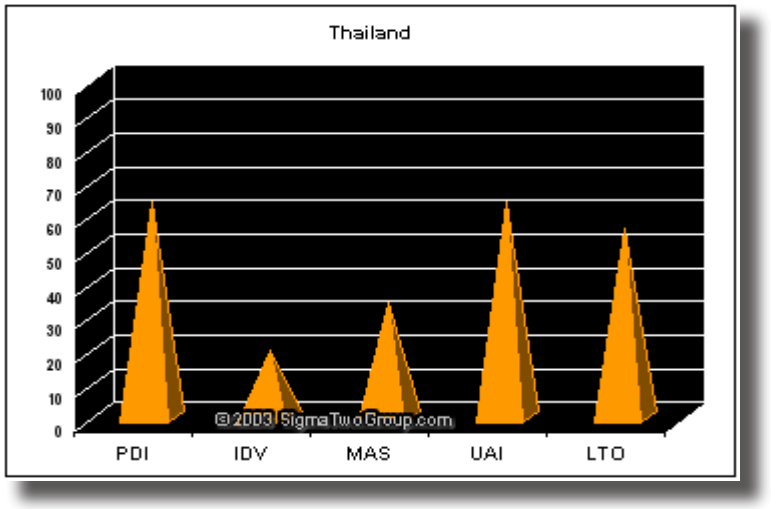


Fig 7. Scores of Thailand for the five cultural dimensions

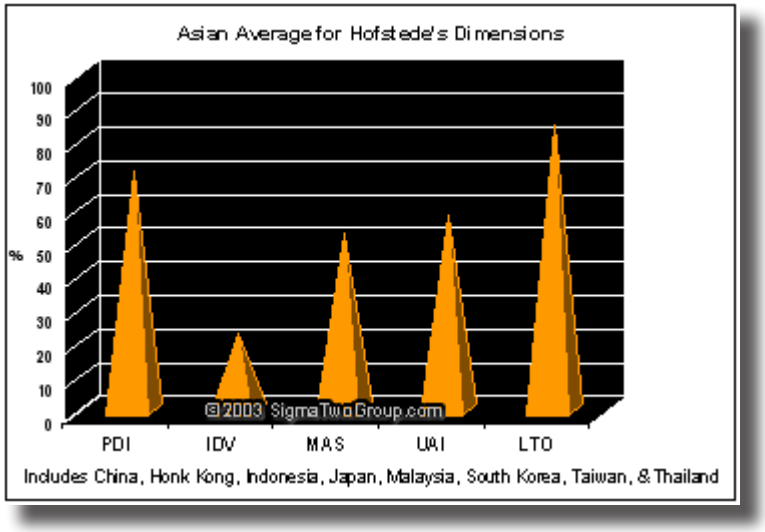


Fig 8. Average scores of Asia for the five cultural dimensions

Individualism

Individualism is explained by ITIM international (http://www.geert-hofstede.com, visited 1 April) as; "On the one side versus its opposite, collectivism, that is the degree to which individuals are integrated into groups. On the individualist side we find societies in which the ties between individuals are loose: everyone is expected to look after him/herself and his/her immediate family. On the collectivist side, we find societies in which people from birth onwards are integrated into strong, cohesive in-groups, often extended families (with uncles, aunts and grandparents) which continue protecting them in exchange for unquestioning loyalty."

Again Thailand's score (20) on Individualism is comparable with Asians average score (about 23) on this dimension. Because this index is based on the degree to which individuals are integrated into groups, it is expected that Cambodia has about the same score on this dimension. The family bound is strong in Cambodia and often many generations live under the same roof. They all take care of each other, what fits the profile of a collectivistic society.

Relation to the project of individualism

This dimension of Hofstede complements with Societal Organization of Ball et McCulloch. Putting emphasis on the benefits for the whole family makes a product more interesting for a potential client in Cambodia.

Masculinity

Masculinity is an index that refers to the versus distribution of roles between the genders. The ITIM international (http://www.geert-hofstede.com, visited 1 april) explains that the assertive pole has been called 'masculine' and the modest, caring pole 'feminine'.

This index shows a different score for Thailand (34) than the average of Asia (53). The explanation of the ITIM international for this low score for Thailand is as following: "This lower level is indicative of a society with less assertiveness and competitiveness, as compared to one where these values are considered more important and significant. This situation also reinforces more traditional male and female roles within the population." (http://www.geert-hofstede.com, visited 1 april) The first reasons mentioned can best be related to the Buddhistic way of life. Because of the great acceptance that Buddhist have in life for everything, they become less assertive and competitive. As a second ITIM implies that there is a more traditional role for male and females in the Thai society.

Because most Cambodians have the same way of accepting things in live and dividing the male and female roles it is expected that the index of Cambodia will lie more around Thailand's score than Asians average.

Relation to the project of masculinity

The low level of assertiveness and competitiveness and the conservative way of thinking of Camodians could mean that they are less open for new things. This probably includes a new technology like solar energy. Connecting this with their day to day live would make this more acceptable for them.

Uncertainty avoidance

According to the ITIM international (http://www.geert-hofstede.com, visited 1 april) the uncertainty avoidance index deals with a society's tolerance for uncertainty and ambiguity; it ultimately refers to man's search for Truth. It indicates to what extent a culture programs its members to feel either uncomfortable or comfortable in unstructured situations.

The score of Thailand (64) is slightly higher than the Asian average (58). It is probable that Cambodia's score lies somewhat under these two scores. The Buddhist religion comes with many (unwritten) rules, regulations. But because the government isn't at full force for a very long time after the Pol Pot area, the laws and policies are still developing. But this still means that Cambodian society probably doesn't readily accept change and is risk adverse.

Relation to the project of uncertainty avoidance

This is a difficult dimension to link to the project, because there have been so many changes in the structure of life for Cambodians the last few decades. But experiences tell that because of all these changes they have become somewhat suspicious against anything unknown. This might be a problem with presenting this new technology, so again it is important to make it understandable and trustworthy for the Cambodians.

Long-term orientation

This last cultural dimension was added later to the other four dimensions. There is somewhat less data on this last cultural dimension. This index deals with Virtue regardless of truth. According to the ITIM international (http://www.geert-hofstede.com, visited 1 april) values associated with Long Term Orientation are thrift and perseverance; values associated with Short Term Orientation are respect for tradition, fulfilling social obligations, and protecting one's 'face'.

There is quite a difference between Thailand's score (55) and Asia's average score (84) on long term orientation. Again, this is probably due to the Buddhist religion. The religion comes with respect for tradition, fulfilling social obligations, and protecting one's 'face'. This is exactly what gives short term orientation in this cultural dimension.

In Cambodia's society the Buddhist religion and preventing losing face is very important. This indicates that Cambodia's score is far more likely to correspond with Thailand's score than with the high average of Asia.

Relation to the project of long-term orientation

Cambodians don't plan the future, they accept what comes along every day. They find it difficult to understand that a bigger investment can be cheaper in the long term than a cheap investment. Therefore the specific benefits of a solar home system must be very clear to the Cambodians, to convince them to buy a system.

2.4 Conclusion

There are some main conclusions that can be withdrawn from this cultural analysis and divided into two main groups. There are some pitfalls for a western designer that has to design for the Cambodians because of the different in culture. The possible problems found through this analysis are:

- The expectation is that Cambodians have a conservative attitude towards change and innovations
- Investing in a long term solution is almost unknown in Cambodian society.
- During interviews connecting with the local people can be difficult because of the specific rules and values in the social contact with Cambodians.
- Because of the high illiteracy rate the use of text must be minimal.

Then there are some possibilities that arose from this cultural analysis:

- The family is central in the Cambodian society, what means that products are more appealing if there are benefits for the whole family.
- Getting respect by having a high social status is very important. Products can also improve one's social status.
- Women are responsible for the household money and must also be addressed by in the marketing / educational material.

In the design phase of the project, all these problems and possibilities have to be taken into account.

Chapter three

"Energy situation in Cambodia"

3. Energy situation in Cambodia

Introduction

To realize what solar energy can mean for the people in rural areas it is important to get insight in their present and future energy use, energy demand and expenditures on energy. First of all these insights are acquired by researching the different resources of energy used in rural areas in Cambodia. Complementary the uses of these energy sources are described. The expenditures and total energy use are described in the final section.

3.1 Energy sources in Cambodia's rural areas

Rural households in Cambodia use many different sources of energy to supply their energy demand. Not only do they use different energy sources, it is common that different energy sources are used for one purpose. For example; Firewood, charcoal and possibly LPG are used for cooking. Which sources they use strongly depends on the wealth of the household. The different types of energy sources are described:

Electricity

There is no national electricity grid in Cambodia. There are 24 isolated grids that supply the major cities, provincial and small towns. The Cambodian Research Centre for Development, also known as CRCD, (CRCD, 2006, page 4) concluded that only 11% of the population has grid connection.
It is clear that grid electricity is only available for households living in the major cities and only affordable for the upper social class in rural areas. In the figures of a report of the MIME (Tun Lean H.E. et al., 2007, page 35) the difference in electrification level in social classes becomes apparent. The government of Cambodia has set a goal to increase the number of households that are connected to grid electricity. This will probably reduce the great difference between the electricity prices in provinces today, which can be seen in figure 9.

Province	Supplier	Tariff USDc
Rattanakiri	Public	5-16
Kratie	Public	30
Prey Veng	Public	28
Kampot	Public	30
Svay Rieng	Public	30
Kampong Chhnang	Public	28
Battambang	Public	24.5
Pursat	Public	28
Banteay Meanchey	Public	38
	Public	40
	Thai	12-15
Koh Kong	Thai	12-15
Pailin	Private	38
Siem Reap	Public	16-23
Tokeo	Public	23
Kampong Cham	Public	22
PP and Kandal	Public	8-18
Sihanoukville	Public	12-18
Stung Treng	Private	46
Kampong Speu	Private	35-38
Mondulkiri	Private	38
Kampong Thom	Private	24
Preh Vihear	Private	38

Fig 9. Electricity prices in Cambodia

	Kampong Speu			Svay Rieng		
Social Class	Type of house	% per type of house	Battery capacity in ampere	Type of house	% per type of house	Battery capacity in ampere
1	Brick	60 %	120	Brick	57 %	77
	Brick/Wood	74 %	83	Brick/Wood	83 %	76
2	Wood/Tile	83 %	78	Wood/Tile	88 %	68
	Wood/Corrugated Asbestos	77 %	66	Wood/Corrugated iron	90 %	62
	Wood/Corrugated Iron	75 %	72	Wood and thatch	92 %	58
3	Thatch	60 %	61	Thatch/Corrugated iron	84 %	44
4				Clay/Corrugated iron or thatch	74 %	42
	Total (average)	75 %	76	Total (average)	85 %	57

Source: MIME 2007

Fig. 10 Battery use per social class

Batteries

Lead acid car batteries are important for providing energy for households in Cambodia. These batteries are mainly used for lighting and TV. According to a study of the UNDP (Brun et al., 2002) the life of batteries are estimated at around 2 years and the costs of an average battery is around 20 US$. The UNPD study (Brun et al., 2002) suggest that batteries are charged at local "charge shops" twice a week on average, with a monthly fee around US$1 a month per battery.
The use of batteries is very high among all social classes, though lower social classes use more batteries. This is probably because higher social classes can afford electricity through grid connection. There is also a difference in the amount of ampere of the batteries that are used. Richer households often use batteries with more ampere than poor households. Figure 10 shows these differences resulted from a research in the provinces Kampong Speu and Svay Rieng (Tun Lean H.E. et al. 2007). More

Grid power use

Average electrical consumption per household: Phnom Penh: urban – 3.98 kWh/day; rural – 1.19 kWh/day; Provinces: urban and rural – 1.19 kWh/day

Battery use (pattern 1)

Energy usage of 156.8 Wh/day, equivalent to using black and white TV (30 W) and lighting (20 W) for three hours daily

Battery use (pattern 2)

Energy usage of 300 Wh/day, equivalent to using color TV (50 W) and 2 lightings (20 W) and fan (10 W) for three hours daily.

Fig. 11 Battery use in Cambodian households

detailed info on battery use in Cambodian households is shown in figure 11. This table suggest that there are two types of battery users. One household with only a black and white TV and lighting that consume about 157 Wh per day and a richer household with a color TV, lighting and a fan that consume about 300 Wh per day. This information is very valuable for comparison with solar energy, because the battery seems to be the toughest concurrent of the solar home system. Although the statistics give a good idea of the situation, it is essential check these statistics in the region of the Kamunasal shops. The literature emphasizes the differences between the different provinces of Cambodia. Therefore more information from field research is described in chapter 7.

Firewood

Firewood is one of the most important energy sources in Cambodia, mainly used for cooking. Cambodians use collected firewood and purchased firewood. The upper social class uses less collected wood and purchase more wood, because they have more disposable income. According to the MIME research (Tun Lean H.E. et al. 2007, page 35-36) the average use of purchased wood is around 4.75 kg per day and the average use of collected wood is around 5 kg per day. In the same research the costs of 1 kg of firewood costs 200 riel (about 0.05 US$) and delivers 15,5 MJ. This results in a price of 46.4 Riel per kWh (1.18 US$ cent per kWh). The total costs for one day of average wood usage will be around 1000 Riel, around 25 US$ cents.

Kerosene

Kerosene is a energy source that is mainly used for lighting. Most households prefer to use electricity for lighting, either by using batteries or through grid connection, but these alternatives are too expensive. But the price of kerosene is also very high for rural households. According to the MIME study (Tun Lean H.E. et al. 2007, page 35) the use of kerosene in poor households in rural areas is above 80%. The same research estimates the use of kerosene around 1.5 liter per month per household. According to the MIME data Kerosene costs from 3000 to 3300 Riel (76.3 – 84 US$ cents) per liter and delivers 44.8 MJ. This results in a price of 241.2 – 265.3 Riel per kWh (6.10 - 6.71 US$ cents per kWh). The total costs for one month of average kerosene usage will be around 4725 Riel, around 1.20 US$.

Charcoal

The upper social classes use charcoal for cooking besides firewood. The use of charcoal depends on income and location. In some areas the availability is very low, and it can be very expensive especially compared to the cheap firewood. So it is hard to give a specific average quantity that is used on a daily basis, because these factors vary among rural areas. MIME (2007, page 44) does make a estimation of the costs for 1 kg charcoal to be around 300 to 500 Riel (7.64 – 12.7 US$ cents) and the energy value 28.9 MJ. Based on this information, the price per kWh is 37.4 - 62.3 Riel, 0.95 - 1.58 US$ cents.

LPG (gas)

Although most families prefer using LPG for cooking, it is only used by the richer families for this purpose. Where charcoal is considered quite pricy for cooking, LPG can be considered as the most expensive of cooking energy sources. The average use is about 6.7 kilos per month, but it must be mentioned that these figures mostly represents the upper social class and some of the middle social class households. The average use of LPG in the lower social class is around 2 -3%. This is not only because the high cost of LPG, but also because of the high investment for the stove that works on LPG. MIME (Tun Lean H.E. et al. 2007, page 44) estimates the costs of 1 kg LPG around 3500 – 3750 Riel (89,1 – 95.4 US$ cents) and the energy value 47.3 MJ. Based on this information, the price per kWh is 266.4 - 285.4 Riel, 6.61 - 7.08 US$ cents. This gives a total average cost of 45 US$ cents per month for the use of LPG in the higher social class.

	Monthly expenditure in $ per household		Monthly expenditure on energy sources in $ per household		% of expenditures on energy sources on total expenditure	
	Kampong Speu	Svay Rieng	Kampong Speu	Svay Rieng	Kampong Speu	Svay Rieng
Upper social class	122	74	13.41	6.93	11%	9%
Middle social class	73	52	7.72	4.05	11%	8%
Lower social class	35	33	4.04	2.66	12%	8%
Lowest social class	-	23	-	2.32	-	10%

Fig. 12 Expenditures on energy compared to total household expenditures

Costs

All these data described in the section above is combined in the table that is shown beneath in figure 12. It shows that the difference in price between wood and charcoal and the rest is quite large. But it has to be taken into account that wood and charcoal are used for cooking. So for lighting and other household appliances like a small TV they strongly depend on the more expensive energy sources.

"The average expenditure on energy sources ranges between 11-12% of the total expenditure per month for households in all social classes" according to MIME (Tun Lean H.E. et al. 2007, page 36). The results of the MIME study (Tun Lean H.E. et al. 2007) concerning the expenditure on energy sources compared to the monthly expenditures per household are shown in figure 13. This information can be used later on to compare the costs of buying a solar home system and charging a battery.

Energy source	Quantity	Costs per unit (Riel)	US$ cent per kWh	Riel per kWh
Wood	1 kg	200	1.18	46.4
Charcoal	1kg	300 - 500	0.95 - 1.58	37.4 - 62.3
LPG	1kg	3500 - 3750	6.61 - 7.08	266.4 - 285.4
Kerosine	1L	3000 - 3300	6.10 - 6.71	241.2 - 265.3
Publicly provided electricity (urban)			18.3	720
Batteries	1 ampere	1000 riel		

Fig. 13 Overview of costs per energy source

3.2 Energy demand

The energy demand in Cambodia is growing steadily at the moment. But when the country is going to develop more and more the energy consumption will grow heavily. At the moment batteries are very popular but already the electricity grid is being expanded in a slow but solid pace. The situation at the moment is very favorable for the introduction of solar home system, but could change suddenly when real progress in development is taking place in Cambodia, because this would mean an explosive growth for houses connected to grid electricity.

3.3 Conclusion

It is very clear that the target group uses many different sources of energy. Wood and charcoal are used for cooking and are cheap. Grid electricity, LPG and Kerosene are far more expensive than wood and charcoal and used mainly for lighting, TV's and radios.
The solar home systems are meant to be used for a small TV, lighting and maybe a radio or fan. Cooking is not one of those, because this needs a lot of energy, demands new and expensive cooking equipment and has very cheap alternatives in wood and charcoal. LPG is also mostly used for cooking and that is why it is not a big concurrent for a solar home system. There is almost no grid connection in the rural areas and it is very expensive, so this is not a very competitive factor for the solar home systems.
This means the biggest concurrent of the solar home system is the battery for both TV and lighting and kerosene only for lighting. The target group would rather use electricity for lighting than kerosene, so this is a pre for the solar home system. So the main focus points of the information display must be why a solar home system is better for the target group than the use of a battery.
Altough this chapter gives a lot of answers about the energy situation in Cambodia, it also raises new questions. The used literature sometimes contradicts each other and it shows a big difference in the energy situation between different parts of Cambodia. The main concern is to check these numbers in practice. In chapter 7 describes field research on among other things, the use and costs of a battery, what appliances are used in a household and the usage of these appliances in practice.

Chapter four

"Solar Energy"

4. Solar Energy

Introduction

One of the main goals of this research is to create awareness on solar home systems. Because the experience of Kamworks is that there is little to no knowledge about solar energy this can't be done without first explaining the basic principle of solar energy. With this information it is possible to list the most significant information for the target group on solar energy. After that the situation of solar energy in Cambodia will be explored.

4.1 Basic Principle

(http://science.howstuffworks.com/solar-cell.htm/, visited 15 April, 2008)

Sunlight is converted in many ways into solar energy, but solar energy that is directly converted into electricity is of interest for this assignment. This way of converting sunlight is called photovoltaic solar energy. Almost everyone in the western society has seen some example of photovoltaic solar energy. A very simple application is a solar powered calculator. But in a developing country like Cambodia almost no one is aware of this sort of conversion of sunlight directly into electricity.

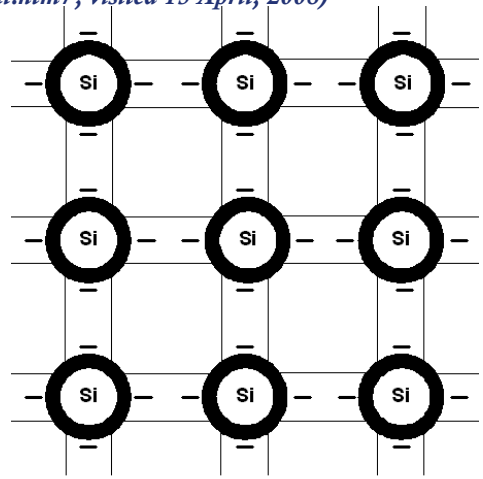


Fig. 14 Atomic structure of silicon

There are many different types of material used in photovoltaic cells that convert sunlight in electricity. In this case only the solar cells with silicon are described, because this is the material used in the solar panels of Kamworks' solar home systems.

The material silicon has a crystalline atomic structure (fig. 14). A silicon atom has fourteen electrons arranged in three shells, where the outer shell carries four electrons. Because the third shell can carry eight electrons, four spots are open for other electrons. All atoms try to fill these empty spots and they do this by sharing their outer shell electrons with other silicon atoms. The remarkable thing about silicon is that it shares its four free spots in the outer shell with four different silicon atoms. This gives the very solid structure of a crystalline. Silicon is called a semiconductor, because it doesn't conduct electricity very well due to this rigid structure.

To make silicon a better conductor for electricity that is activated by radiation of sunlight, the silicon is made impure (fig. 15). By mixing a very small amount of phosphorous the structure of the silicon slightly changes. Phosphorous has five electrons in its outer shell and three free spots. Despite that there are only three free spots, the phosphorous atom still shares electrons with four silicon atoms. This leaves one electron to run free in search of another free spot it could fill. Radiation of sunlight makes most of these free electrons to break free.

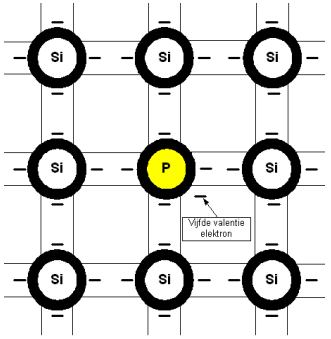


Fig. 15 Impure silicon with phosphorous

If silicon is mixed with a very small amount of boron has the opposite effect (fig. 16). Boron only has three free electrons in its outer shell. Sharing electrons with four silicon atoms still leaves one free spot. These free spots are nothing more than the absence of electrons. This gives the silicon mixed with boron a positive charge.

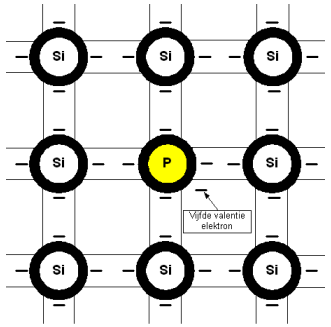


Fig. 16 Impure silicon with boron

A solar cell exists out of to layers of silicon with impurities. One layer is a layer with phosphorous, also called the N-layer. The N stands for negative, because the free electron gives it a negative charge. The other layer contains boron, also called the P-layer. This is because the free hole gives it a positive charge. When these two layers come in contact, the electrons start moving from the N-layer to the P-layer.

Not all the free spots of the P-layer will be filled with electrons of the N-layer. Because the electrons crossing over to the P-layer will fall into the first hole that they can fill. This causes a barrier for crossing electrons at the junction. This barrier causes the electric field between the two layers. This barrier only

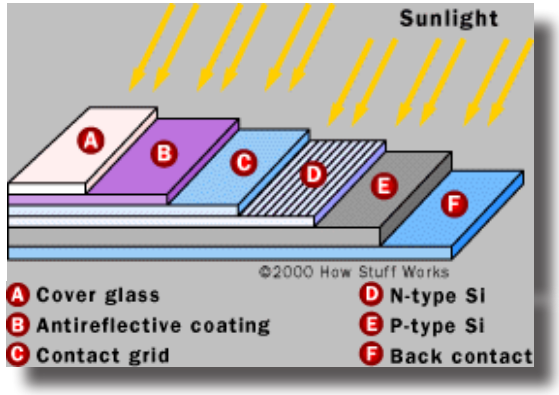


Fig. 17 Layers of a solar cell

allows electrons to cross over to the P-layer, but the reverse is not possible. When the radiation hits the solar cell even more electrons will break free and cross over to the P-layer. All these negative electrons crossing over to the P-layer disrupt the electrical neutrality. When a wire connection is made between the P-layer and N-layer, these electrons can flow back to the N-layer and the whole process can start again from the top. Electrons are moving from one spot to another, forming electricity.
To optimize this process there are two more things that form a solar cell. Sunlight makes the electrons break free, but silicon is a very reflective material. To absorb as much incoming sunlight an antireflective coating is applied on top of the N-layer. On both the P- and N-layer an electrode contact layer is applied to make the electric flow possible when wires are connected (to other solar cells or the battery). To protect the cell a glass cover is assembled on top of the cell (fig. 17). The solar cells can be connected to each other, which multiplies the amount of power with the number of solar cells connected.

4.2 Solar Energy in Cambodia

As explained before, unfortunately there is little knowledge of solar energy in Cambodia. Cambodia can be seen as a very suitable country for solar energy because of its geographical location. The average insolation in Cambodia lies around 5 kWh/m2/day according to Kranen (Kranen, 2007, p. 14). This unit is roughly comparable with 'hours of direct sunlight per day' if direct sunlight is set at 1kWh light energy. This is an ideal situation for a steady solar energy supply through a SHS.

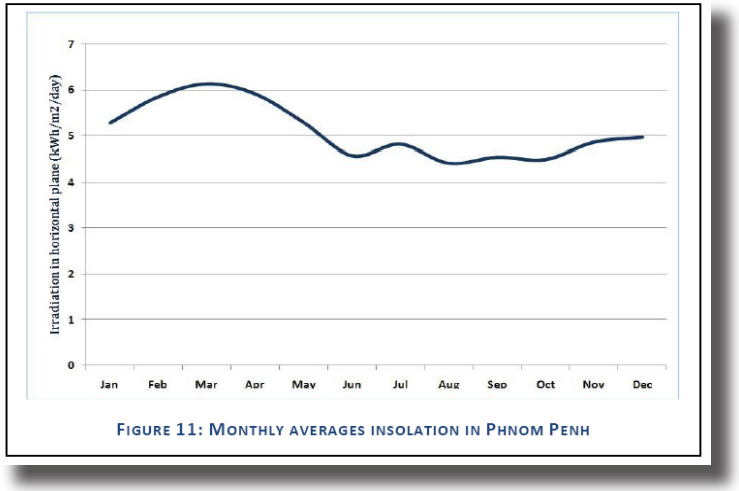


FIGURE 11: MONTHLY AVERAGES INSOLATION IN PHNOM PENH

Fig. 18 Monthly average insolation in Phnom Penh

Despite these advantages, the use of solar energy is limited in Cambodia. Most of the implementation of solar energy systems are financed or supported by NGO's. Examples of these projects are health clinics or small hospitals and schools with no grid connection that get a steady energy supply by using a solar home system. Solar energy for private use isn't widely spread through Cambodia. Some are familiar with small product that work on solar energy like a flashlight, battery charger for mobile phones or a small radio. But almost no Cambodians have a solar home system for private use.
The Cambodian government realized that renewable energy can be of a great use. First of all this can improve the electrification situation in rural areas. Part of the rural electrification development targets of the Cambodian government is about the renewable energy action plan.
Interesting for Kamworks of this renewable energy action plan for selling solar home systems is that the government has started a subsidy program to achieve the targets. This program must reduce the cost of a solar home system with US$100 per system. The government hopes this makes it more attractive to make the investment when they buy a solar home system. This advantage will be discussed in the cost comparison context in section 5.2.

The UNDP (Brun et al., 2002) did research in the development of the Photo-Voltaic market in Cambodia. One of the fields of research was "knowledge and interest for solar photovoltaic technology". They questioned several shop owners on different subjects. First of all, also interesting in this case, what their marketing strategy is. The results are shown in figure 19. The UNDP study (Brun et al., 2002) concluded: "Basically, we can say that retailers have a "static" conception of trade. They are waiting for the customers and not going to them. The most common marketing practices are more designed to make the client come again, rather than to attract new clients." Kamworks has no clients yet, because it is a new brand with new shops. Attracting new clients is

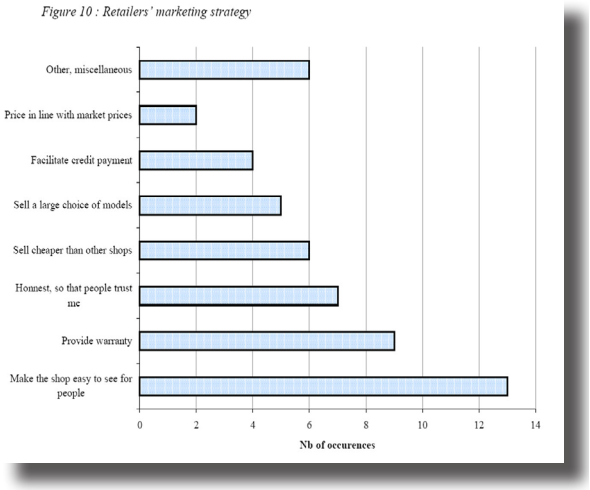


Fig. 19 Marketing strategy of Cambodian retailers

very important in this stage and can also make a difference between the marketing strategy of Kamworks compared to competitors of Kamworks.
There are no exact numbers on the knowledge of rural people about solar energy. But the study by UNDP (Brun et al., 2002) did test the knowledge of battery retailers on solar energy (fig 20). There must be taken into account that these battery retailers are more likely to get in contact with this technology because they are in the "business". And second of all, Cambodians tend to answer with yes when a question is asked because they think this is what the questioner wants to hear. Despite these two facts it gives some idea of the knowledge on solar energy in Cambodia.
The main constraints that the shop owners mention are the high costs of solar energy. This is the reason why more then 40% of the retailers think that people in rural areas are not interested in a solar home system.
During this project there is a group of Cambodians in the solar campus that is being trained to be a Kamunasal micro-entrepreneur. Because they have more insight in the material on solar energy, they might be able to give good ideas on this matter. This could be for example on how to attract new clients and make the high investment of a solar home system attractive for potential clients. A brainstorm session with these micro-entrepreneurs about this and related issues is described in chapter 7. The absence of exact numbers on the knowledge of rural Cambodians about solar energy also gives reason to do some field research on this matter. This is also described in chapter 7.

Figure 16 : Knowledge of battery/TV retailers on solar

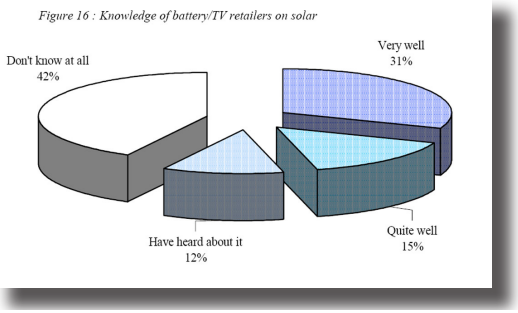


Fig. 20 Knowledge on solar energy of battery / TV retailers

4.3 Promotional material on solar energy in Cambodia

There are a number of comparable businesses to Kamworks active in Cambodia. These shops are mostly in the city far from the shops Kamworks placed and is planning to place. Cambodians don't really travel long distances to buy household goods because of the road conditions and they often only own a motorbike.
These shops already have some promotional material they use to inform potential clients. All the shops use folders for this goal. They are directed at people that are already aware of solar energy and have some technical awareness. Some examples are given below in figure 31.

Fig. 21 Promotional material in Cambodia

4.4 Conclusion

Although it is important to know how solar energy works in order to explain it to people, the theory is to complicated and it is not wise to try and explain all of this. It is better to keep it very basic, because the knowledge on solar energy is poor and illiteracy makes it even harder to explain it thorough.
Solar home systems are definitely not widely spread throughout Cambodia, despite the fact that the country is almost ideal for this technology. According to the research among shop owners in Cambodia one of the most important reason for this are the high costs of the solar home systems. So it must be made very clear to the target group that the costs are relatively low on the long term, only the investment is expensive. The subsidy program of the government can reduce this investment with US$100, which should make it more attractive to buy a solar home system.
It showed that the shop owners do not have any sort of a marketing plan for their shops. One of the major flaws in this is that they don't attract new clients to the shop. An information display could help them to improve this, for example with an eye-catching part which can attract new people to the shop. In order to keep these new clients attracted and learn about solar energy the shop owner could explain things they see by starting a conversation with them.
The promotional material of possible competitors is very much alike, it are all similair folders. This creates an option for Kamunasal to be different from their competitors and use something different from a folder.

Chapter five

"Solar home system"

5. Solar Home System (SHS)

Introduction
In this section the solar home system of Kamworks will be introduced. The following will be discussed; the parts of a SHS, costs comparison, user scenarios and the ad- and dis-advantages of a SHS. At the end the useful information for the display will be summarized.

5.1 Introduction to a Solar Home System

There are two types of solar home systems; grid connected and autonomous. The first is connected to the grid so it can deliver redundant electricity to the grid (when the battery is full) and use electricity from the grid (when the battery is empty). An autonomous solar home system is not connected to the electricity grid and only delivers electricity to connected devices or the battery.
Kamworks is going to put 3 different types of the solar home system on the market, a medium model, a large model and a luxurious model. All of these systems can be used as an autonomous system, but the luxurious model can also be grid connected. The medium and large models are 12 Volt DC systems. The luxurious model is 220 Volt AC system and therefore compatible with the 220 Volt AC of a grid connection.

Fig. 22 The Kamunasal Solar Home System

The components of a Kamworks solar home system (fig. 22) are:
Solar panel
This is the combination of several solar cells, which converts the sunlight into electricity.
Batteries
The batteries store the electricity converted by the solar panel. The batteries can deliver this stored electricity when this is needed even when there is no electricity supply by sunlight.
Charge controller
Batteries have a longer live when a system contains a charge controller. The charge controller makes sure the batteries aren't overcharged or drained.
Invertor (only in the luxurious system)
An invertor is used to convert the DC electricity that the solar panels deliver into AC electricity.

The specifications of the components of the three systems are almost similar to each other, with the main exception of the current of the solar panel. The medium solar home system has a short circuit current of 2.65 Ampere and the large and luxurious systems have a short-circuit current of 5.08 Ampere. The equation P = I x V explains why higher current results in more power supply, where P is power in Watts, I is current in Ampere and V is voltage is Volts. When I is increasing, P also increases, so the solar home system with more current gives a higher result of Wattage. The full specifications of both the solar panels and the battery that is used for both systems are given in appendix A.

5.2 Cost comparison

A solar home system requires a relative big investment, and the question is if buying a SHS is attractive for a potential client. The costs based on the lifespan of the components of a SHS are calculated and compared to the competition.
Because batteries are the strongest concurrent of the solar home system this is the most important energy source to compare to. In section 3.1 was described that an average battery costs US$ 20 and has an estimated life of 2 years. Most households spent US$ 1 per month on charging the batteries. This gives a total cost of US$ 44 per battery during its total lifespan and US$ 22 of total costs per year.
The costs of the solar home system are not so easy to estimate because it has more components and these all have different life spans. The small solar system costs around US$ 400 including the US$ 100 subsidy of the Cambodian government. The average solar panel has a lifetime of 20 years or more, only the other components have a shorter life. An overview of the lifespan and costs of the components of the small system is given in figure 23.

Component	*Price*	*Product lifespan*	*Price per year*
Solar panel	$ 260	20 year	$ 13
Battery	$ 80	4 year	$ 20
Charge controller	$ 25	10 year	$ 2.50
Construction	$ 35	20 year	$ 1.75
Total	$ 400	-	$ 37.25

Fig. 23 Annual costs of a small Solar Home System

The costs of the small solar home system are higher compared to the most used battery by the target group. These figures might be interpreted as that a battery is a more attractive source of energy, because the price is a very important factor for them. But these figures are not enough for a full comparison.
The small solar home system supplies energy for lighting and a black and white TV. The battery is mainly used for TV and lighting, but Cambodian households often use kerosene in addition for lighting (as described in section 3.1). The costs for a month average kerosene use was calculated at 1.20 US$ in section 3.1.
With this information it is possible to give a fair comparison of the small solar home system used for TV and lighting and the currently used energy sources by the target group for TV and lighting. Adding the costs of kerosene for lighting gives a total costs for currently used energy sources for TV and lighting of around 37 US$. With this outcome the small solar home system and the batteries cost almost the same per year.
The costs of the larger solar home system are considerably higher. With the subsidy of US$ 100 the total costs for this system are around US$ 900. Obviously this system isn't cheaper than the use of a battery and kerosene for TV and lighting. This system is mainly an alternative for the higher social class that has more money to spend and uses more household goods with a higher Wattage. An overview of the lifespan and costs of the components of the larger solar home system are given in figure 24.
This theory must be tested with information from field research to check if the literature was right about the use and costs of batteries. This will be done in section 6.1.

Component	*Price*	*Product lifespan*	*Price per year*
Solar panel	$ 760	20 year	$ 38
Battery	$ 80	4 year	$ 20
Charge controller	$ 25	10 year	$ 2.50
Construction	$ 35	20 year	$ 1.75
Total	$ 900	-	$ 62.25

Fig. 24 Annual costs of a large and luxurious Solar Home System

5.3 User scenarios

Potential clients of a solar home system will be interested in the possibilities of the solar home systems. Therefore different user scenarios are made in this section to find out what the capacity of the solar home system is. Because there are two types of solar home systems this is done for both of them.
As mentioned before the small solar home system works on 40 Wp. This means that direct full sunlight on the small system gives a maximum power of 40 W. Cambodia has a very steady solar irradiation throughout the year of 5 hours direct sunlight. This gives 200 Wh of electricity per day that the user can divide over different household goods. Because the system has an efficiency of around 80 percent the actual electricity per day is 160 Wh. The smaller system is meant for households that use little household goods. It is a realistic assumption that an average household has a black and white TV of 40W and 3 DC lights of 7 W. In figure 25 different options for the user are set out.

TV 40W	*TV Wh use*	*Lighting 2x7W*	*Lighting Wh use*	*Total Wh use*
4 hours	160	-	-	160
-	-	11.5 hours	160	160
3 hours	120	3 hours	40	160
2 hours	80	4 hours	80	160
1 hour	40	8.5 hours	120	160

Fig. 25 User scenario for a medium Solar Home System

The television is a large energy consumer. The lighting doesn't consume a lot of energy and can be turned on for many hours when the TV isn't on for more than 2 to 3 hours.
The larger solar system works on 78 Wp and gives 390 Wh per day with 5 hours of direct sunlight. Again, this system has an efficiency of 80 percent, which leaves energy of 312 Wh. A household with this system can use more household goods, for example a color TV (60W), 3 lights (11W per piece), a small fan or radio (20W). A few user scenarios are described in figure 26.

TV 60W	*TV Wh use*	*Lighting 3 x 7W*	*Lighting Wh use*	*Radio or Fan 20W*	*Radio or fan Wh use*	*Total*
4 hours	240	3.5 hours	72	-	-	312
3 hours	180	5 hours	100	1.5 hours	32	312
2 hours	120	6 hours	132	3 hours	60	312
1 hours	60	8 hours	165	4 hours	82	312

Fig. 26 User scenario for a large or luxurious Solar Home System

This second solar home system gives more freedom to use different household goods for a longer time. But the television is still a large energy consumer, so when the TV is used less the other household goods can be turned on significantly longer.

5.4 Advantages compared to the disadvantages

Because the costs of a small solar home system and batteries used for lighting and TV are almost the same it is important to define the advantages and disadvantages of the solar home systems and batteries together with kerosene.

Solar home system

Advantage	*Disadvantage*
Continuous supply of energy	Big investment (on the short term)
Clean energy	No knowledge
Noise free energy	Availability of spare parts
No charging of batteries	Service after buying
Highly reliable	Many components, all with a different lifespan
Almost no maintenance	
More and better energy supply compared with other energy sources in rural areas	
Long lifespan	
Comparable costs with the alternative on the long term	

Battery

Advantage	*Disadvantage*
Small investment (on the short term)	Must be charged twice a week
Well known in rural areas of Cambodia	Sudden shortage of energy, because of empty battery (no continuous supply of energy)
Widely available	
Only one components	

Kerosene

Advantage	*Disadvantage*
Small investment on the short term	Dangerous, change of fire
Widely available	Fumes and smell
Cheap components	No continuous supply of energy
	Insufficient lighting

The solar home system has many important advantages for the target group. The only important disadvantage is the big investment on the short term. An expert on the solar home system of Kamworks is Tom van Diessen, who is designing and testing the system for the Kamunasal shops. Together with another expert he will give his ideas on communicating about the solar home system and solar energy in the expert interviews in chapter 7.

5.5 Conclusion

An important question is which part of this information about the solar home systems is relevant for the target group. Because the main concern on solar home systems of the target group is the high investment, the comparison of the costs with the energy sources the target group uses today is valuable information. Because the target group is already familiar with a battery and this is used in the comparison, they can relate better to this new technique.
Besides the costs it is also important and relevant to present the target group with information on what a solar home system can mean for them. Most important is concrete information about what household goods they can use and for how long. This has some overlap with the advantages of a solar home system. From a commercial point of view the most important advantages are those that put the solar home system in a better daylight than the use of batteries and kerosene. These are especially the fact that a battery of a solar home system charges itself with sunlight and that it has a very long lifespan. These are the most important positive selling points for the solar home system and have to be represented on the display.

Fig. 27 Rendering of respectively the medium, large and luxurious home box

Chapter six

"Introducing innovations in Cambodia"

6.Introducing innovations in Cambodia

Introduction

One of the main problems found in chapter 2 was that Cambodians are not really open-minded towards innovations. When the introduction of the solar home system fails, this can be disastrous for the Kamunasal shops. Reason enough to dig deeper into the subject of introducing innovations in Cambodia. This will be done in several stages.

First, the model of acceptance of a new and innovative product of Van Raaij et al. (2004) will be used. This results in the most important characteristics that will influence the introduction of the solar home system.

Second, the hierarchy of needs for the Asian society by Schutte and Ciarlante (1998) is described. This gives more insight into consumer behavior of Asian people.

After that, a more educational approach for introducing innovations is used. The transfer of information when explaining new information is discussed in the last section of this chapter. This results in a concrete educational plan for the target group.

6.1 Rural Cambodian consumers

The solar home system is a totally new product on the rural market of Cambodia. For a right placing of this product in the market it is interesting to use the model for acceptance of innovations (Van Raaij et al., 2004). This model gives ten characteristics that influence the acceptance of a new and innovative product. In a report of Kirsten Rijke (K.C. Rijke, 2008), the importance of each factor was described for the Cambodian rural market. The results of this research are given below in order of most to least important characteristic;

Price

As expected in a developing country, the price (together with the related quality) is seen as the most important factor. Although the products with a higher price are often of better quality, the poorer families cannot afford to buy these more expensive products. Almost all people prefer to pay the full price in one time, not to pay in terms.

Quality

Quality is considered as a very important characteristic, next to the price. But it is very hard to judge the quality before purchasing. The most attractive things of buying a good quality product are less maintenance and special benefits, like a brighter light.

Fulfillment of obvious needs

Especially for the poorer families, the basic needs are first fulfilled. The rang order of needs was found to be the following; Food and water, light, electricity.

Relation / interaction

Consumers rather buy at a shop where the salesperson is known, otherwise the promises of quality can easily be a lie. If this happens a consumer will not return to this shop.

Observability / communicability

Consumers consult the shop owner about the quality and working of the product. After this other users of this product are asked for experiences. In general the known brands are considered to be of good quality. Word-of-mouth is important in the rural areas.

Complexity

Products may not be to complex and understandable for the consumer. If they don't understand the working of the product, they will rather buy another easier product.

Affiliation

The consumers tend to buy things that make the whole family happy and not just for themselves. Also neighbors sometimes come and see a new purchased good.

Relative advantage

Longer lifetime and warranty are considered as advantages, but often the poorer families cannot afford the higher prices of these products.

Trialability / divisibility

Consumers want to try the electronic products they buy out in the shop. They want to buy the product that worked in the shop, not the same product still in its package. The bigger brands use activation shows that allows the rural people to try and experience products. This creates trust with the rural consumers.

Risk

The risk factor is not of great importance for the rural costumer. This is mostly because it is almost impossible to know the risk factor when buying a product and warranties are not usual.

Availability

Consumers prefer a great assortment of products in a shop, because they think it makes it easier to choose the best price and quality.

Admiration and social status

Not as important as expected, but still an important characteristic. New products are shown to neighbors and give a certain degree of admiration. Especially a family that has light at night receives more admiration. With a good experience other consumers are advised in buying a similar product.

Compatibility
The consumers are not especially concerned about the compatibility of the product with their lifestyle. Moreover because most purchases are done to fulfill basic needs. They like to stick to the brands they know unless their experience with this brand is bad.
Speed of the effect
Effect must be seen in short term, especially for the poor.

6.2 Consumer behavior

There is al lot of knowledge about consumer behavior in the western society. Schutte and Ciarlante (Schutte et al., 1999) applied different consumer behavior theories on the Asian society. Maslow created the hierarchy of needs for the western society, which Schutte and Ciarlante converted into a hierarchy of needs for the Asian society.
This hierarchy is a pyramid that starts at the bottom of the pyramid with the basic needs, which are food, water, housing, air, sleep etc. The higher on the pyramid, the less vital the needs are. As can be seen in figure 28 the three higher levels of the pyramid are different for the Asian society. Belonging is replaced by affiliation, prestige by admiration and self-actualization by (social) status. Although this pyramid is a reflection of whole Asia, it is somewhat representative for Cambodia.
This third layer of the pyramid confirms earlier conclusions that Cambodians are concerned with their family. Admiration and the higher level social status are far more important in Asia and as well in Cambodia, although the poorer households cannot afford to care about admiration and social status. This is more a concern of the middle and higher social class.

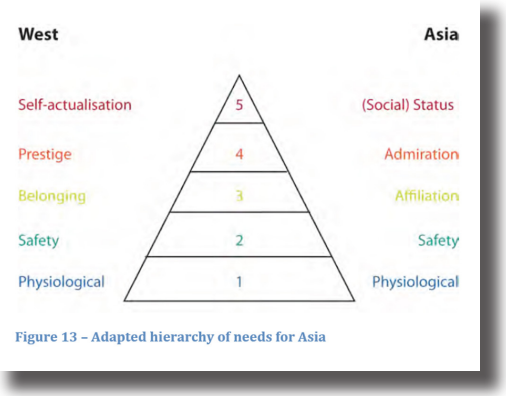


Figure 13 – Adapted hierarchy of needs for Asia

Fig. 28 Adapted hierarchy of needs for Asia

6.3 Information transfer

For this project it is essential that the relevant information for the target group about solar home systems and solar energy is correctly transferred to the target group. To get insight in transferring information to a group, the theory of Kolb (Kallenberg, 2006) is used.

Kolb describes a cycle of learning that is displayed in figure 29. According to Kolb there are two dimensions in the learning process; Concrete experience against abstract ideas and active against passive. There can only be a full learning process when all four dimensions are used. It depends on the person what dimension is the starting point.
Kolb subtracted four learning style types out of the cycle of learning; Designer, thinker, decider and actor. There different types all have a different starting point in the learning cycle of Kolb. This is shown in figure 28. The different types will be discussed shortly:

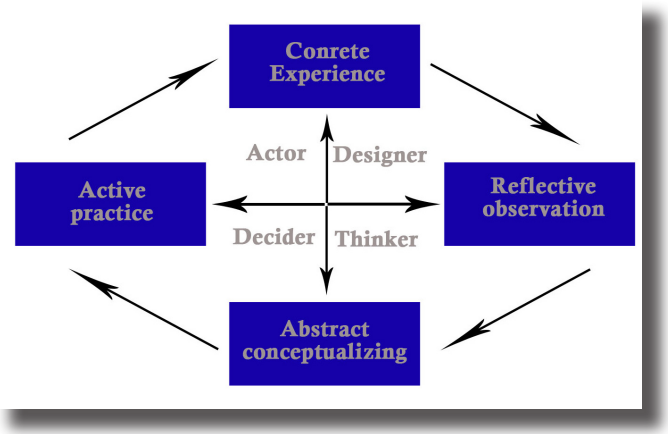


Fig. 29 Cycle of learning by Kolb

Designer
The designer prefers observing others work before starting themselves. They are not fond of abstract ideas, but rather learn by doing themselves after observing others.
Thinker
The thinker will first try to get an abstract idea in his head before starting. After this, the result is reflected with work of others.
Actor
The actor starts immediately with enthusiasm, but will probably experience problems along the way. That's where the decider will take a step back and try to form some abstract ideas in his head and match the ideas with reality.
Decider
The decider always knows where it is going, because he already made decisions in his head. When he experiences problems he will try to make new decisions to solve this problem in an analytical way.

Although the theory of Kolb is normally used for higher education, it can contribute to finding the best approach to transfer the new information to the target group. Determine the learning style of rural Cambodians could help find this best approach. In previous sections was found that the current learning style used in schools to educate in Cambodia isn't sufficient. This learning style only uses two out of four steps of the Kolb learning cycle. First they make an abstract concept and then they practice the learned abstract concepts. When only these two steps are taken, there is no step that relates things to reality. Without this link to reality there will never be full understanding of what is exactly learned.
Here follows a theory from a western point of view on where the Cambodians stand in the learning cycle of Kolb:
It is unlikely that Cambodians that live in rural areas are thinkers, because they, especially the older generation, are not used to learning new things. As mentioned before they have the tendency to accept things that are already known and avoid uncertainty.
Because the information will be totally new for the target group it is likely that they will have a more waiting towards this new technology. The actor tends to immediately start working with this new technology. In this specific situation it is not expected that the target group will act as an actor.
In theory it seems best to use an approach that is adapted to the style of a designer combined with a decider. But again, this assumption must be treated carefully, because this is a theory based on a western society.

Because there is an educational aspect in this assignment, a closer look will be taken at the way an educational plan originates. This can help to optimally transfer the new information to the target group. The theory of Gal'perin is used to get insight in a way of transferring this new information. A schematic overview of the learning process used in educational institutes is shown in figure 30.
The theory describes four in stages in the process of learning. In this case the first two stages are most important, because it is more important to provide them with basic information than learning the technical aspects of solar energy and solar home systems.

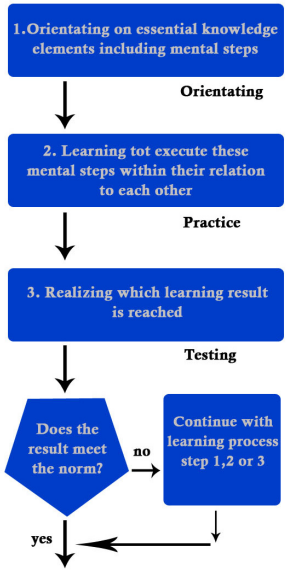


Fig. 30 Learning process in educational institutes

The first stage in the process of learning is all about orientating on the essential elements of knowledge. The orientation is especially important when new information is provided like in this assignment. Without a good orientation it will be almost impossible for the target group to catch up with the new information that is provided. A good way of orienting on new information is use an example of something comparable that is familiar for the target group. This could be for example that the sun gives energy to the rice plant, which allows it to grow. This is recognizable for the rural Cambodians, because they already experienced this in their live. In order to prepare on the orienting stage the following must be clear:

- The expected result of the learning process
- The needed resources; divided in procedural knowledge (strategies etc) and declarative knowledge (theories, laws etc)
- Description of the actions that have to be taken

In this first stage it is desirable that the target group has insight in the learning goals and is motivated to learn about this new information. This could be difficult in this situation, because it is Kamworks in the first place that wants the target group to learn about the new information, not the target group itself.
In marketing this is also known as the push and pull strategy. In this situation the new technology should be pushed towards the potential clients through marketing. A solution could be to trigger the curiosity of the target group with for example an eye catcher. The curiosity could then develop into motivation to learn about this interesting thing they experienced.
The second stage is all about working with the information they absorbed in the first orienting stage. An active way of learning suits this stage best, where immediate feedback is preferred. This is because wrong steps could be remembered incorrectly when there is no feedback. When the final outcome of the assignment is an information display, the shop owner could give feedback to the steps the target group (potential clients) made. There probably will have to be a guide for the shop owners to support the information display.
The third stage is optional for this assignment. This stage describes that the information that is learned must be tested. The suggestion of the theory is to use a tentamination or give an assignment. In this case this is not preferable, but it could be useful to test the final design with for example a small questionnaire or interview to see if the information is transferred correctly.

6.4 Educational Objectives

Audience – Who is the target group?
The target group is Cambodians that live in the rural areas of Cambodia of the middle social class. They don't have a grid connection and use a maximum of 4 to 5 lamps, a black and white or color TV of a maximum of 60W, and possible some other small household appliances.

What do I want the target group to learn?
- That sunlight can provide energy.
- That there is a system that can store this energy, a solar home system.
- How they can use this solar home system for their household goods.
- To know and acknowledge the advantages of a solar home system compared with other common used energy sources.
- To realize that the costs of a solar home system are comparable with the use of a battery's.
- To be able to reproduce this new information to inform other people (like the family).

Behavior – What behavior is expected?
A reserved attitude towards new information is expected. The new information will be accepted easily, but turning this acceptance into knowledge and acknowledge will be difficult.

Condition – How are the conditions?
The target group will receive this information at the stationary Kamworks shops in the rural area's. The shop-owner is from the same village and knows many people. He or she can give additional information.

Degree – What are the criteria and is the level of the target group?
Criteria
The educational materials will be successful if the target group understands that the sun can provide affordable and reliable energy for their household appliances by the use of a solar home system.

Level
They don't have to have any knowledge about solar energy and solar home systems. Oral information is absorbed better than information by letter. The illiteracy rate of the target group is quite high.

6.5 Conclusion

Several important things can be concluded from this chapter. First of all the most important characteristics of acceptance of innovations in Cambodia are; Price, Quality and fulfillment of obvious needs. These characteristics applied to the introduction of the solar home system can give a very positive image of the product;

Price
A solar home system gives comparable costs compared with a battery and has far more benefits.

Quality
A solar home system has a very long lifespan and needs almost no maintenance. European technology is used for the solar home system. This has a far better reputation then all the Chinese technology products that overflow the Cambodian market.

Fulfillment of obvious need
Electricity is the third need for the Cambodians. This means electricity is vital for Cambodians and the solar home system can help to supply this need.
To achieve the optimal results of understanding the new information about a solar home system the concept must suffice the following points:
- The attention of the potential clients must be drawn with something that triggers their curiosity.
- The learning process includes immediate feedback. Because the learning tool is a display the feedback must be given by the shop owner, who can guide the potential client through the learning process.

It is clear that the Cambodian consumer differ in a great deal from the Dutch consumer. Therefore it might help to create more insight in the Cambodian consumer by information from field research and experts on this subject. This is explored further in chapter 7.

Chapter seven

"Field research"

7. Field research

Introduction

In the previous chapters a lot of literature was analyzed to gain information for this project. But with a project in a country that is so different from the Dutch culture it is worthwhile to retain information through field research. The literature on Cambodia is limited and the options for own research are almost endless.
Therefore three different types of practical research were performed, where each research dealt with a different involved party. The first was a questionnaire for potential clients at house visits. Second, a brainstorm with the Kamunasal micro-entrepreneurs (future shop keepers) was performed. And finally, experts on the Kamunasal brand and the Kamunasal solar home system were interviewed.

7.1 House visits

Methodology

In the analyses in the previous chapters several parts were indicated as point of attention for field research. In this research the points that had any relation to the potential clients were processed. The most important points of attention for this research were:

- The main energy supply in a household (chapter 3)
- The costs of the main energy source (chapter 3)
- Knowledge on solar energy (chapter 4)
- Consumer behavior (chapter 6)

The best way to get answers on these points was to go to the target group and use a questionnaire. This was already a familiar way of performing field research at Kamworks. A translator from Kamworks who was familiar with the projects of the students was available for house visits.
Because there is a translator between the questioner and the respondent, the questionnaire mostly contained questions that required only a short answer. In addition the translator was asked to emphasize this during the house visit. This was in order to minimize the change on translating flaws. The questionnaire can be found in appendix B.
The in total eleven house visits were spread over three days. Each day an area that was within reasonable driving distance with a motorbike of one of the two Kamunasal shops was chosen. Every day a different location in this area was chosen to prevent that the results are based on similar households.

Results

House	*Source of energy*	*Lamps*	*TV*	*Other appliances*	*Usage TV / lamps (hours)*	*period between charging (days)*	*charging costs (riel)*	*price battery (US$)*
1	2 batteries (70A)	3	0	-	4	2 to 3	2500	20
2	2 batteries (40 & 50A)	1	1	-	4	2	2000	?
3	2 batteries (70A)	6	1	-	4	2 to 3	3000	18
4	1 battery (70A)	2	1	-	4	2	2000	> 10
5	2 batteries (70A)	1	1	-	2	7	2000	30
6	1 battery (70A)	2	1	-	1	7	2000	50
7	1 battery (50A) + generator	2	1	radio	2 or 3	3	?	?
8	1 battery (50A)	1	0	-	1	3	1500	?
9	1 battery (40A)	1	1	-	2	3	2000	40
10	Generator	5	1	CD player	2	?	?	?
11	2 batteries (50 & 70A)	2	1	CD player	4	2(50A) and 10(70A)	1750	75

Fig. 31 Results house visits

A table with the results of the house visits is shown in figure 31. There were eight houses with one or two fluorescent lights, the remaining three houses owned 3, 5 or 6 lights. All families turned on their lamps for some hours after dinner. The duration of lighting at night lies between 2 to 4 hours per evening. Only two houses didn't own a television. The houses with a television turn it on for about one to two hours a day. Most of them try to save energy by using the TV for a shorter period then they would actually want to use it. There are two families that own a CD-player for karaoke besides lamps and a TV.
Of the eleven families that were interviewed two were connected to a small grid from a generator. All the others owned car batteries, varying from 40 to 70 Ampere. The houses with older (8) batteries would charge their battery every two to three days. The houses with the newer batteries (3) charged their battery only after 7 to 10 days. The charging of a battery costs about 2000 riel per time, this is 0,50 US$. Charging places can be far or near depending on the location of the house. The original price

of the battery has great variety between the houses. The range of the price goes from 10 to 75 US$. This is due to the level of ampere, the brand and when they bought it. Almost no respondent knows what solar energy is and if they know than they only have heard about it and have never seen it. All houses have no idea how this new technology works and what it could mean for them.
If the respondents want to buy a new product in the shop half of the houses prefer a model of the product to get more information about it, the other half preferred pictures.
One of the questions was to draw a battery, to get insight in the mental model of a battery. The drawings of the battery are somewhat diverse. All are drawn as a box, but the details are different. Most of the people draw the small caps on the battery, but not the right amount of caps. The car batteries are 12 Volt batteries with 6 small 2 volt units that give the 12 Volt in total. The caps indicate the separate 2 Volt units. Most people know that there are two poles on the battery, because they can see these every day on the battery. They have to put clamps on the poles to connect the battery to electrical equipment. Only four of them draw a positive and negative symbol next to the poles. Some think the brand name is also important to draw, because this gives a good indication of the quality for them.

Discussion

Based on these results, the price of a small solar home system is comparable to using a battery if they use it for at least 10 years. Earlier, based on literature, the assumption was made that Cambodian's living in rural areas pay around US$ 40 per year for lighting and TV by using a battery and kerosene for lighting. According to the field research they don't use kerosene lights and they pay US$ 60 for charging and probably at least US$ 10 per year for the original price of the battery (based on an average cost of US$ 20 and a lifespan of 2 years). This is a total expenditure of US$ 70 per year for using a battery.
This shows that the reality is different than the situation on paper. This is a known problem in Cambodia. A lot of people have more money than they admit, because they have several extra jobs, for instance as a tuk tuk driver or a small shop on a market. This makes the literature research less reliable and the answer has to be found somewhere in the middle. This research would be more valid if a higher number of houses was visited, but due to time restrictions and personal issues this was the highest score possible.
The assumption on the number of appliances was close to the results in this research. Most households owned one TV and around three lamps. Confirmed by both literature and field research this can be used as the model situation in information material. The starting point of explaining solar energy must be from the beginning because the knowledge on batteries is limited and there is no knowledge about solar energy. According to this research a combination of pictures and a model could be ideal for explaining a solar home system to the target group.

Fig. 32 Respectively a battery of a Cambodian family and a house visit

7.2 Brainstorm with micro-entrepreneurs

Methodology

In chapter four a motive for further research on the ideas of shop keepers was given. In the literature the shop keepers were skeptical about solar energy. The training of micro-entrepreneurs was a perfect opportunity for a brainstorm session on this and subject. The trainees already had the technical part of the training, which provided a solid knowledge on solar energy and the solar home system. The brainstorm session was performed together with another student, because that project had overlaying interests with this project. The experience of Kamworks is that Cambodians tend to be a bit awaiting towards brainstorming. So to reach optimal results the brainstorm session was divided into the following steps:

1. Explanation subject

An introduction into the main questions of the session.

- Promoting the shop
- Boost sales

2. Warming up

A physical exercise to create a blank and open minded state of the group.

3. Group discussion

The group discussion has to get the group thinking about different aspects of the subject.

4. Association game

The whiteboard is used to get associations from the group on the aspects of the subjects found in the group discussion.

5. How Can You's

The associations are all assessed in groups by the How Can You strategy, where the micro-entrepreneurs write ideas on how to solve aspects of the brainstorm on a large paper.

6. Generate ideas

All ideas on the subjects can be written / drawn by the micro-entrepreneurs separately.

7. Choose

The micro-entrepreneurs choose the ideas that they value best together.

Fig. 33 The micro-entrepreneurs in the solar campus

Results

After a slow start the micro-entrepreneurs showed great enthusiasm in brainstorming. Unfortunately they had not many concrete ideas on how to solve the main problems, although the session was useful to confirm some suspicions. The interesting results from this brainstorm session are:

- Tell the customers about the advantage of using solar panels
- Import good quality and effective products
- Train the shopkeeper on how to attract clients
- Making customers aware about solar panels
- Making sure that the customers know about the products. If not, tell them about quality and advantage.

Discussion

It shows that quality, advantages and attracting people are important according to the potential shop keepers to sell the products. All these aspects were already found in previous analyses and prove their importance again. These points must be emphasized in the concept.

7.3 Expert interviews

During the developing of this project, two overlaying projects are also being developed. Kirsten Rijke is defining the brand Kamunasal and designing the Kamunasal shops. Tom van Diessen is designing and testing the solar home system that is still in development. These three projects are so close to each other that the expertise of both Kirsten Rijke and Tom van Diessen is very useful for this project. That is why in an interview both were asked what they think are the most important factors for this project according to their expertise.

Kirsten Rijke discovered during interviewing Cambodians that price, quality and benefits are very important to Cambodians when they buy new products. She states that these factors must be elaborated on the information display. Cambodians are tend to buy the cheapest product of all the different choices, so as found before it is important to explain why this bigger investment is cheaper on the long term.
Cambodians have a very clear idea on how to judge the quality of a product. When a product is made in China it is of very bad quality and when it comes from Japan it is of top quality. In between are Thai products that are considered bad quality and Vietnamese products that are considered of acceptable quality. European and American technology isn't really represented in Cambodia, but most Cambodians consider these products to be of good quality. According to Kirsten Rijke (2008) potential clients care about the country of origin and this should be pointed out in the information display.
Another very important decision factor for Cambodians that Kirsten Rijke found in her research are the benefits of a product. Rural Cambodians take all the benefits into account when they want to buy a new product. So emphasizing the benefits in de display can help convince potential clients to buy a solar home system.
Tom van Diessen experienced during tests with the solar home system that many families have unrealistic expectations of the solar home system. The test families expected an unlimited supply of energy because of poor technical knowledge. The main cause was that they didn't understand that a lamp, television or other appliance with a lower wattage uses less electricity and therefore can be used longer. He fears that this could influence the reputation of the product "solar home system" and the brand "Kamunasal", because the disappointment in both product and brand is spread through mouth-to-mouth. A short introduction about wise use of connected appliances could avoid this according to Tom van Diessen.

7.4 Conclusion

The field research gave some new insights for this project. The house visits revealed that the use of a battery is more expensive than the literature research showed. This is a very positive point for selling a solar home system, because this makes it even cheaper on the long term compared to a battery.
The brainstorm session and expert interviews resulted in four points that must be emphasized by the information display:

- Quality
- Price
- Benefits / advantages
- Use of appliances in combination with a SHS
- Attracting clients

Chapter eight

"Design phase"

8. Design phase

8.1 Design criteria

In the previous chapters conclusions were drawn from literature and field research that have to be translated into a design. Therefore an overview of the keywords of every chapter's conclusion is given in figure 34. It is apparent that there is a correspondence between keywords. This creates an opportunity to group keywords together in main criteria for concepts. Each corresponding keyword is grouped with the corresponding words and placed under a design criterion in figure 34. This list offers the possibility to grade concepts on criteria that cover all important aspects of the previous analysis phase. The criteria are further explained underneath;

Informative

In which degree is the concept informative for the target group? Many aspects of a SHS and solar energy are a mystery for the target group and must be able to be explained by the concept. Especially the poor knowledge on solar energy must be improved by the concept, and the technical knowledge on how to use appliances in combination with a solar home system.

Commercial

In which degree is the concept able to generate new clients for Kamunasal? Attracting new clients is a well known problem in the Cambodian energy business. The concept should be able to attract potential clients to the store and preferably let them enter the store. From there the shop keeper should keep the potential clients attracted. There are many options to be different then the very small group of competitors, because their promotion consists mainly out of technical folders.

Benefits

In which degree can the concept explain the important benefits for the consumer? The decision whether to buy a product is heavily based on the benefits / advantages of a product. If these convince them that the product is useful, they are very interested in buying it. There must be enough opportunity in the concept to explain all these benefits to the potential clients in a clear way, to promote the solar home systems.

Quality

In which degree can the concept convince the potential buyer of the high quality of the solar home system? Quality is a very important aspect in choosing between similar products. The degree of quality is assessed by the country of manufacture. The Cambodian consumer scale of quality can roughly divided into three degrees.

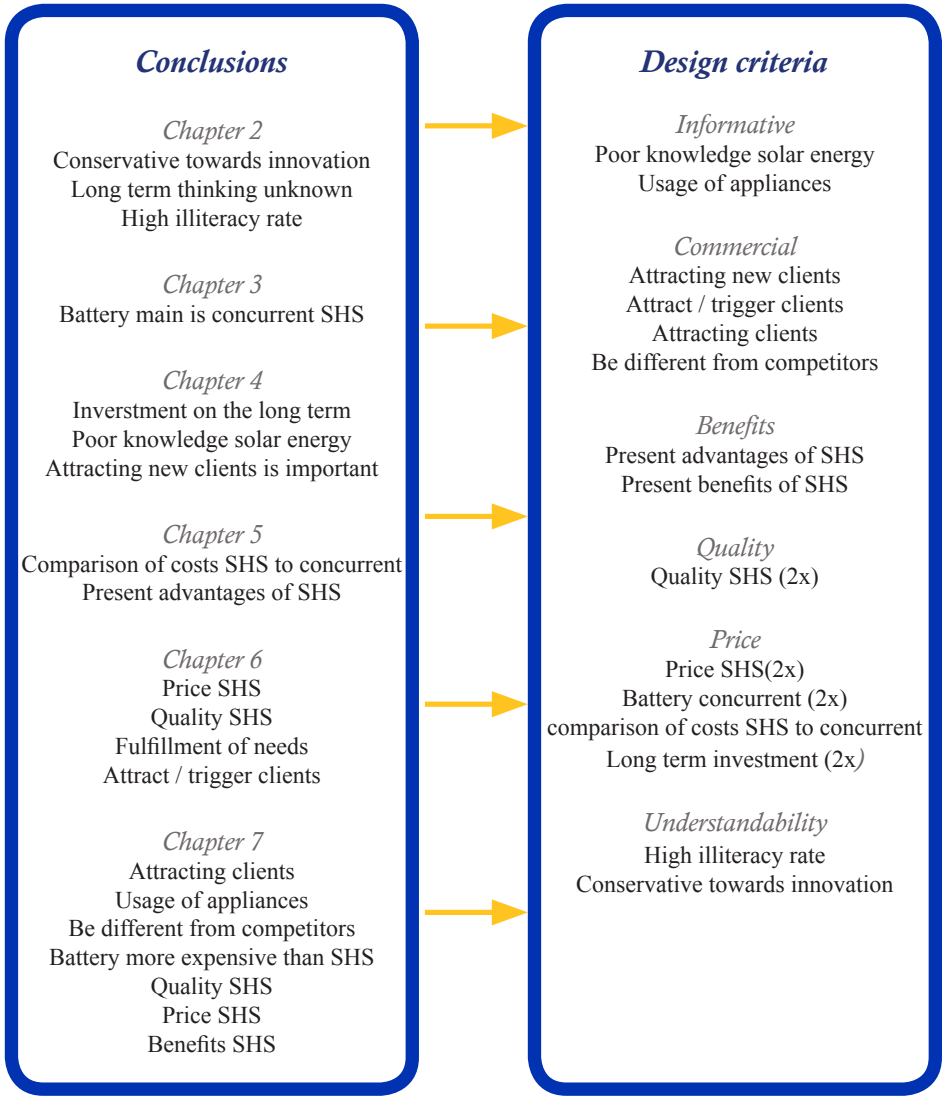


Fig. 34 Translation from conclusions to design criteria

Good: Japan, Europe, America
Medium: Thailand, Vietnam
Bad: China, Cambodia

The concept must be able to emphasize the quality of a solar home system, because the quality of the Kamunasal solar home systems is good on the Cambodian scale of quality. The solar panel is Japanese and the technology is European.

Price

In which degree can the concept explain that a solar home system is a relative cheap option for the target group? Price is always an important aspect for consumers. A returning topic in this project is the long term investment that a solar home system requires from a consumer. The concept must be able to explain that in comparison with the concurrent "the battery" a solar home system is a cheaper alternative.

Understandability

In which degree does this concept appeal to the target group? The target group has a high illiteracy rate and is conservative towards new technology and in schooling. This gives design limitations for concepts. The concept must be understood by the target group in context of amount of text, recognizability of the design, learning principles of the design etc.

8.2 Concepts

After the analysis phase the conceptual phase was entered. In this phase ideas are generated on a broad scale. This resulted in many sketches that can be found in appendices F, G and J. The main criteria made it possible to choose in an early stadium of the concept phase, in order to create more time for the final concept. With these main criteria in mind a selection of three ideas was made. These three concepts are described below.

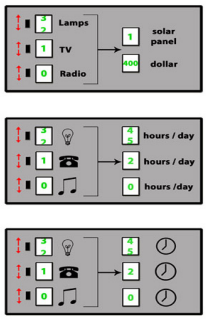


Fig. 35 Idea 1a

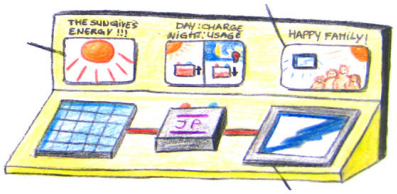


Fig. 36 Idea 1b

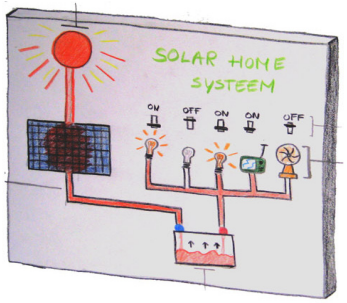


Fig. 37 Idea 1c

Concept 1: Display

This concept uses the initial idea of an information display from Kamworks. This is a display that can display all kind of information about a solar home system and solar energy. Three possible options within this concept are created and described below. These different ideas can be combined when selected as best concept.

Idea 1a: Usage information display (fig. 35)

This information display is a two dimensional display that explains the usage of a solar home system. It is an interactive display that can be adjusted to the situation of a client. The amount of different appliances is input for the display. The information display than generates an output. This output can be for example the amount of needed solar panels, the amount of hours that the appliances can be uses in combination with a SHS or both, etc.
This display should make potential clients aware of the options and usage of a solar home system. It can support the shop keepers with the explanation on solar home systems. A disadvantage of this idea is that there is no explanation on the working of solar energy, so the potential clients are still in the dark on this technique.
The production options for this interactive display are good for the actual display, because it is not a difficult construction. The technique to make it interactive might be too time-consuming and parts to make it work could be hard to find. This must be taken into account if this idea is selected.

Idea 1b: Overall information display (fig. 36)

In this idea the display is three dimensional and covers a broader selection of topics on solar energy. The parts of a solar home system are represented in the display and the client is guided through the process by pictures of the principle. When the budget allows it, a television screen can be integrated. This will create options for commercial purposes, providing information etc.
This idea should provide potential clients with overall information on solar energy and a solar home system. But because of the great amount of topics that can be discussed, the danger is that the information is too superficial.
This display would take more time to build, but there is no interactive part that requires technical parts.

Idea 1c: Principle of solar energy information display (fig. 37)

Like idea 1a, this is a two dimensional display. The main theme of this display is the working of a solar home system. It shows how the solar energy is stored in a battery and is used when appliances are turned on. The flow of energy can be indicated with for example LED-lights or a stream of fluid. There is a small interactive part in this

display, as the clients can turn appliances represented on the display on or off. This can underline that some appliances use more energy than other and that this has consequences for the battery status.
This idea combines the principle of solar energy together with creating some awareness on the usage of appliances. Just like in idea 1a, this information can be too specific. From a commercial point of view it lacks explanation about the benefits, costs etc.
The construction of this display is not complicated to make within the possibilities of Kamworks. The only remark is that the technology to make it an interactive display could be too complicated to realize. The parts are difficult to get and the guidance time is limited.

Concept 2: Model of a SHS (fig 38)
This concept was initiated because fifty percent of the interviewed Cambodians indicated that looking at a model of the product they want to buy helps them on deciding whether to buy it or not. This concept shows the working of a solar home system. It is divided in two ideas that are described below.


Fig. 38 Concept 2

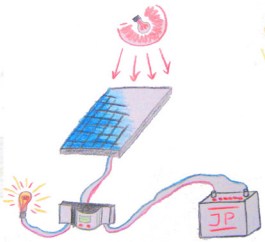


Fig. 39 Idea 2a

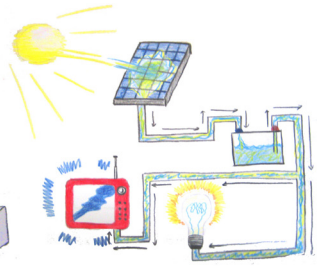


Fig. 40 Idea 2b

Idea 2a: Working prototype of a SHS (fig. 39)
Cambodians like to see a product work before they buy it. Because a solar home system is a relative large sized product compared to the relative small solar shop, placing a working solar home system would be too much. A solution for this problem can be a scale model of a solar home system, that shows all the parts that a solar home system contains. By using a real solar panel on scale the system could be activated with a strong lamp, which represents the sun. Different appliances can be connected to show the working of the system.
This concept seems to fit the needs of Cambodians to see a product working. But this way of deciding to buy a product is used for products or techniques they are already familiar with. In this case the product is unknown and unrecognized as a good product, so it is important to give additional information on this new product.
If Kamworks can provide the parts of a solar home system on scale, this idea can be realized easily. Kamworks already has working solar home systems, so this scale model uses the same technology on a smaller scale.

Idea 2b: Model of SHS working on a fluid (fig. 40)
A scale model of a solar home system is actually a very "closed" system, that doesn't show the processes on the inside of the system. This model uses the idea to show the processes on the inside of a solar home system. All the parts of a solar home system are shown from a side view as if they are cut in half. This offers the clients a view in the different parts. By using a fluid (like (colored) water) that represents the energy flow through the parts it gives a very understandable idea of the working of a solar home system. A representation of appliances can indicate that they work on the energy created by the solar panel.
This idea deals with the same problem as idea 2a. It doesn't explain give any additional information about a solar home system except the working of the system. A little more technology is needed for this idea than idea 2a. A fluid must be transported from one place to another in a controlled way. This requires more time to realize this idea, but it does give a better representation of the process of converting sunlight into electricity.

Concept 3: Maquette
This concept shows a solar home system more in the context of the future environment when bought. This should create a familiar situation around this new technique for potential clients. Two different options are generated for this concept and described below.

Idea 3a: A model home with a SHS (fig. 41)
This idea is a more extended version of the idea of a model SHS. To create a feeling of recognition the model is placed in familiar surroundings. A scale model of an average Cambodian house is cut in half to show the situation on the inside. It gives the clients an idea on where the different parts of the solar home system are placed inside a Cambodian house. It shows an ideal situation of appliances, one TV and three lamps that use energy from the solar home system. A sun is placed above the house that shines on the solar panel, so the ideal position of a solar panel on a roof is represented in the concept.

A critical point of this idea is that there only a part of the information on a solar home system is represented. Although the working of a product is vital information for potential clients it might be not enough to convince them to buy it.
Making this model is probably possible in the Kamworks workshop, although it might be difficult to create the small parts with the tools of Kamworks. These are mainly tools meant for steel and rough work.

Fig. 41 Idea 3a

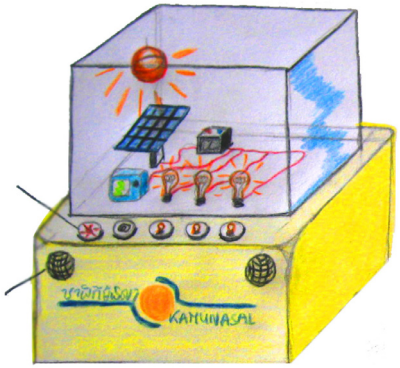


Fig. 42 Idea 3b

Idea 3b: A "museum maquette" of a SHS (fig. 42)
This idea is based on a type of maquette that is sometimes used in museums. It represents a real life situation on a scale and an outsider can control this situation through a playing elements. This way of educative playing might seem a bit childish, but it still attracts adults to try it. In this case the real life situation is the solar home system that is placed in a Cambodian house. The playing elements can differ from changing day to night, turning on appliances to repositioning the solar panel. Speakers can provide information on choices that are made.
This idea could result in a very complete design to provide potential clients with information on solar energy and a solar home system. This depends on the feedback that the system can give through the speakers.
The possibilities to realize this idea are doubtful. A lot of electronics and parts will be needed to technically realize this. The provided tools and the guidance from the company are almost certain not enough to realize this idea.

8.3 Choosing a concept

Because of the limited design time to the concept that meets the criteria best is chosen early in the process. The ratings (fig. 43) for the six criteria are given for the three different concepts. Not all separate ideas are taken into account in this ranking system. The ideas of one concept are all based on the same pillars, therefore the main idea is judged. This also leaves the options for one concept more open, because the ideas can still be combined. The ranking is on a scale from 1 to 5, where 1 is very bad and 5 is very good. The ranking of the three concepts is explained for every criterion.

	Display	*Model SHS*	*Maquette*
Price	4	2	2
Quality	4	3	2
Benefits	4	2	2
Commercial	4	3	3
Informative	4	2	2
Understandability	3	4	3
Total	23	16	14
Average	3.8	2.6	2.3

Fig. 43 Ranking the concepts

Concept 1: Display
Informative (score: 4)
This concept is the only one off all the concepts that can introduce the principle of solar energy besides the working of a solar home system. Because of the poor knowledge on solar energy, this might be an essential missing link to understand a solar home system.
Commercial (score: 4)
Assuming that the budget allows a television screen, this concept has a real eye-catcher. Cambodians are going through the same situation concerning televisions as when the television was introduced in the Netherlands. A television is something new and a big attraction in Cambodia. This can attract clients into the store, so the shop keeper can start to converse with them.
Benefits (score: 4)
The display contains "blank spaces" that can be filled with useful information for potential clients. This could be in visual and/or textual format. This can be adjusted to the target group.

Quality (score: 4)
The "blank spaces" can also be used to explain the potential client about the quality and lifetime expectations of the product.
Price (score: 4)
Here again, the "blank spaces" can still be filled with all kind of information. This also leaves room to explain the long term advantages of a solar home system and compare it to the use of a battery.
Understandability (score: 3)
The possibilities of the "blank spaces" also create a small point of critic. Using small amount to no text because of the high illiteracy rate is almost impossible. Support for bad or slow readers with visual material is vital in this situation.
The concept of a display is fairly unknown by the target group, but this will probably cause no problems.

Concept 2: Model SHS
Informative (score: 2)
This concept doesn't introduce solar energy at all, the working of a solar home system is just presented as a fact. This level of providing information is too low for potential clients.
Commercial (score: 3)
Using a model of a product is a well known way of promoting or selling a product in Cambodia. This makes it somewhat commercial, bit placing a model of a solar home system will probably not attract a lot of clients into the solar shop. Because this is a very important issue in this situation, the score is lower than for the display concept.
Benefits (score: 2)
When a model of a solar home system is used in the store, the potential clients have to draw their own conclusions on the benefits of this system. It is optional that the shop keeper explains all the benefit, but this is a situation that is far from ideal.
Quality (score: 3)
Quality is judged in Cambodia by the country of manufacturing. In this case the solar panel is made in Japan, which is conceived as very good quality by Cambodians. This could be represented on the panel, so this would appeal to potential clients. There are no real possibilities to explain that the system works on European technology, or the product has a long lifetime.
Price (score: 2)
A price tag can give the potential client an idea about the costs of a solar home system, but this does not give any information concerning the concurrent source of energy or the advantages of a long term investment.
Understandability (score: 4)
This concept uses almost no text, so it will be understandable for potential clients that cannot read or have difficulties with reading. The way of presenting a product like this is well known in Cambodia and will be easy to relate to by potential clients.

Concept 3: Maquette
Informative (score: 2)
Here the same objection as with the concept 2 is valid. This concept doesn't introduce solar energy at all, the working of a solar home system is just presented as a fact. This level of providing information is too low for potential clients.
Commercial (score: 3)
This way of presenting a solar home system is easy to relate to for a potential client, because it is placed in a familiar environment. It is not as well known as using a model of a product, but probably has the same effect. Therefore is has the same score as concept 2.
Benefits (score: 2)
Here the potential clients have to draw their own conclusions on the benefits of this system also. This results in the same score as concept 2.
Quality (score: 2)
Because the model of the solar home system in a maquette is even smaller than in concept 2, a sign on the panel about the country of manufacturing would probably not stand out. This means that no information on the quality is given.
Price (score: 2)
Information about the price can be given in a similar way as described for concept 2. This results in the same score. Understandability (score: 3)
The ability to touch and feel this model situation in comparison with concept 2 is limited, because the parts are smaller. This way of presenting a product is new to Cambodians this reduces the ability to understand it. But because the use of text is limited the score results in a 3.

The scores show very clear that the concept 'display' is the concept that meets the criteria best. The main reason is that there is room for text and images to explain aspects of the solar home system. This is very positive for the criteria price, quality and benefits, because these can be explained on the display. This makes the display very informative on different aspects of the solar home system. The concepts 2 and 3 only reveal a little information about the solar home system.
The integrated television in the display also makes concept 1 a very attractive concept. This gives great possibilities for the informative and commercial criteria, because all kind of movies can be played on this screen. It also could be the attractive factor that the Kamunasal shop needs to make potential clients come into the store.

This ranking is assessed by both Kirsten Rijke and Tom van Diessen to check if the ranking is supported by experts on areas of this project. They both shared the opinion that the concept "display" would be the most sufficient in this situation. Jeroen Verschelling from the company Kamworks relied on the opinion of the design experts and left this decision up to them.

8.4 Finalizing chosen concept

By choosing concept 1 there are still various options to use and combine the three created ideas. New sketches were made to try different combinations. Within these sketches the brand Kamunasal was clearly represented for two reasons. First of all, Kamunasal is a new brand that can get more known by letting people see it as much as possible. When the logo is fairly represented on the display, it is more likely that the target group will have a feeling of recognition when they see it again. Second, Cambodians judge quality by brand (which represents the country of manufacturing for them). So if they are aware of the quality of the Kamunasal brand, this will give a positive idea about the information display. This second reason is more for the long term, when the target group for example already bought a small product of the Kamunasal brand and is already familiar with the shop.
After this, the question "what has to be explained on the information display?" had to be answered more specifically. Based on the analysis of the previous chapters the following categories were selected:

1. Benefits
   a. No charging
   b. Easy energy
2. Price
3. Quality
4. Usage
5. Working

Fig. 44 Exploring main topics

A sketch session to explore the way of explaining these five topics was performed. Some of the results are shown below in figure 44, other sketches can be found in appendix G. After exploring how to explain the five main points it became clear that a lot of space was needed to show all this information.
Together with Kirsten Rijke, who was working on the branding of Kamunasal, was decided that the colors of the display should match the colors of Kamunasal. The shop itself is totally yellow, and the Kamunasal brand contains blue and yellow. Orange is also a color used often in other Kamunasal material and in the logo of the mother company Kamworks.
With these condition second version of the sketches were made (fig. 45) :
- Clear branding,
- Enough space for the five main topics
- The use of colors yellow, blue and orange

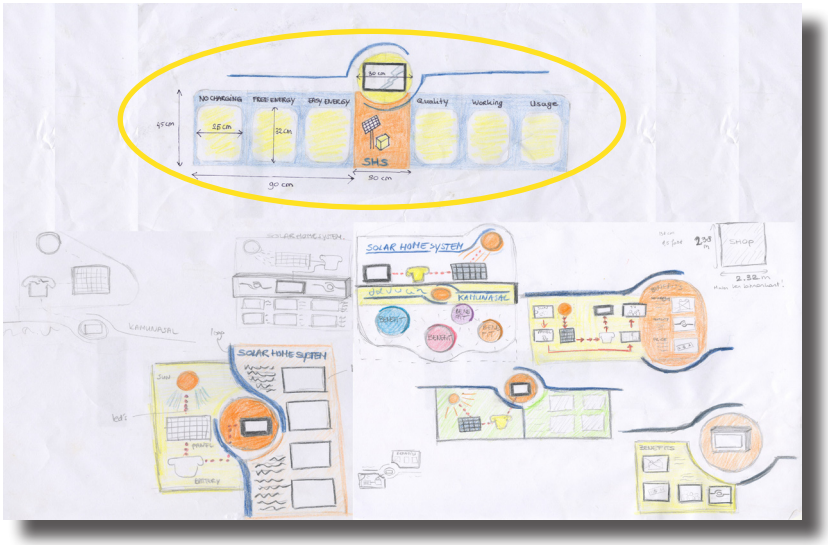


Fig. 45 Second round of sketches

The idea to use posters to explain the five main topics was created in this sketch session. Using posters it is possible to use text and graphics together and create a hard copy print of this. The advantage of the material that is created for the posters is that it can be easily adapted when needed and used for other purposes.
In these sketches the idea of using a model of a solar home system is often present. This caters to the need of consumers to see a working model before they buy it. But after discussing this idea with the company and Kisten Rijke this idea was eliminated. The company wasn't sure if it could provide the parts for this idea, like a small solar panel. Kirsten Rijke explained that she wanted to place a solar home system in the solar shop the provide it of energy and display the product.
After assessing the possible ways to produce a display it became clear that the freedom of shapes was limited. The workshop was mainly suitable for working with steel, not wood. The fact that a jigsaw was absent gave significant design restrictions. This resulted in a selection of shapes that were mainly rectangles with some small curves.

Based on the above three design restrictions the highlighted concept in figure 44 was chosen. This concepts has place to show six posters that can explain the main categories. By using an even number of posters this creates an opportunity to place the television screen in the middle. This makes it the centre of the display, so this can attract the clients into the store. This concept doesn't use a model of a SHS in the display. Because this idea was eliminated, this concept fits the needs better than the other ones. The final decision factor was the feasibility. This concept had the most potential to be created in the way it was designed in the workshop of Kamworks.
A small research (appendix E) answered the question what kind of display could be integrated in the display. A portable DVD-player uses less energy and is more compact than a normal television. After assessing the portable DVD-players on the market the choice was made for a 10.2 inch DVD-player with a screen that can turn 180 degrees and doesn't exceed the price limit of 200 US$.
A more 3 dimensional concept arouse from choosing the screen. To fit this DVD-player into the display it was shifted to the middle panel of the display. This middle panel was brought more to the foreground to fit the control panel that is attached to the screen of the portable DVD-player.

8.5 Final concept

Design

The main construction of the display is a construction of MDF that shows six posters and has an integrated television screen. Above the main construction the logo of Kamunasal is used. This is made out of foam that can be made in a shop where it is possible to use the foam burning technique. This is not possible to make in the Kamunasal workshop. The display covers one of the identical side walls of the Kamunasal shop. Kirsten Rijke, who is designing the Kamunasal shop, will decide whether this will be the left or right side. An example of the model in the Kamunasal shop is shown in figure … The position on the wall places the posters and television on Cambodian eye-height in a standing position. The color of the background is bleu, the poster are placed on a combination of orange and yellow and the middle panel is painted orange with a hole for the screen. A picture of the information display model is shown in figure 46.

Posters

There are six posters on the information display that all cover one of the characteristics of a solar home system. These characteristics are: Cheap energy, easy energy, quality, working, usage and no charging. On every poster a characteristic is explained by graphics in the best way possible. A small amount of text is added to support the graphic. The text gives the information that is useful when the graphic doesn't cover the full characteristic. The posters are displayed in the appendices L (English version) and M (Cambodian version).

Fig. 46 The final model of the information display

Animation

Although the goal was to use a limited amount of text to no text at all on the information display, this was hard to achieve. The diversity of the topics that had to be discussed was great, and needed the support of text. Even though this information is presented in an understandable way, all this information can be difficult to process for the target group. Therefore an informative animation that covers most of the information on the posters is created. This gives the target group the option to get feedback on the things they have seen on the posters. And informative animations are still very unknown in the rural areas of Cambodia and can be the perfect way to attract clients.
The animation is divided into three different parts:

1. Solar energy: What do you need?

The parts of a solar home system are presented and the fact that sunlight is needed for solar energy is given.

2. Solar energy: How does it work?

The working of a solar home system is explained by arrows that represent the flow of energy in the system. The battery fills when the sun is shining on the solar panel.

3. Solar energy: How do you use it?

In the last part the use of appliances in combination with a solar home system is introduced. This aims to create awareness on the wise use of energy to get the most out of the solar system.
Each part uses about one a half to one minute to explain the question. The images on the posters and in the animation correspond with each other to create an

unambiguous way of presenting on the information display. Moving images can improve the level of understanding significant, because there is more freedom in the way of explaining. The animation is therefore less dependent on textual support than the posters. The text that is added is to divide the animation into three parts and to give additional information to the people that cán read.

Commercial song and movie

During the execution of this project a song about solar energy is developed. This song is created and recorded by a Cambodian singer that is famous in the rural areas in Cambodia. This song can be used for different purposes. Possibilities are; Playing the song in the solar shop or the mobile shop to attract attention, make it a single and use this as a promotional item or create images with this song that can be displayed on the TV in the shop. This is a good way of attracting people into the shop. The singer agreed on appearing in a short commercial movie to be displayed in the shop. The main idea of this movie is that the singer tells about her experiences with the solar home system that is placed in the house of the family. All the members of the family enjoy the benefits of the solar home system. Kamworks will develop this idea further, because this is to time consuming for this project.

8.6 Test of final concept

It was not possible to test the full display in the shop, because the new shops weren't placed yet. Also the animation was developed after arrival in the Netherlands. So the items of the display that could be tested were the posters. This was done by house visits in the rural areas. The main goal of the test was to see if the graphics were understandable for potential clients. Besides that the text was tested on grammar and understandability.

The test procedure was as following: The test person was showed a poster one at a time. The text of this poster was covered, so they first had to explain the graphic. When the test person was finished the idea of the graphic was explained and the test person could comment the graphic. After this the text was showed and commentated by the test person. When all the posters were commentated all six posters would be arranged next to each other. The test person could give any additional input on the posters.

The results were very positive. The test persons found some irregularities in the grammar of the Khmer text that was translated by a Kamworks employee. The poster with usage was not always clear for the test persons, because they confused the clocks with a sun. This was adjusted in the final version of the posters. Besides that all the test persons said they found the posters clear and the graphics very attractive.

Fig. 47 Two of the families that participated in the test of the posters

8.7 Production process

The information display must be produced in the Kamworks workshop. This is a small workshop attached to the office of Kamworks with around three to four employees. Most of the parts that are produced in the workshop are made out of steel. This is a disadvantage for producing the information display, because this is made out of MDF. If the workshop was suitable for producing a first series of ten displays was tested by making the model in the same workshop.

The display was made out of two pieces of MDF of 244 x 122 mm. All the parts of the wooden construction of the display are drawn on the pieces of MDF and cut out, as well as the holes for the hanging mechanism and the cut-away for the television screen. Because the proper tools, like a jigsaw, weren't available the parts were cut out with a column drill. This was to time-consuming, so it would be wise to make a small investment in a jigsaw before the other displays will be produced. All the parts had to be sanded, because the column drill left irregularities.

All the wooden parts of the main construction were assembled and given a first layer of paint. The door in the middle construction that allows access to the television screen was connected with two hinges. To support the television screen a small shelf was put inside the middle cabinet.

The six protruding MDF layers to make the posters stand out were glued together with a two-part adhesive consisting out of a transparent resin and a hardener. The posters were connected to these MDF layers with double sided tape. This makes it possible to reassemble or uses new posters when changes are made.

Because the shape of the Kamunasal logo is too complicated to make with the drill column this is made in by a foam cutter.

The production process of the first series won't be very different from the production process of the model. By using proper tools and the experience the workers will get from making more than one display the production time will be significantly shorter.

Fig. 48 The production of the display in the workshop of Kamworks

8.8 Production costs

The most expensive part of the display is the integrated portable DVD-player. Kamworks was a great advocate of an integrated television screen. There was no specific budget for this project, but the costs were discussed in detail with Kamworks and they agreed on every expense that was made for this display.
The total costs of the model are the total costs of the used parts and the labor costs must be added, which are around 1 US$ per hour. Considering that one employee will take around 32 hours to build one display, this results in 32 US$ for one display. This results in a price of $ 300. The different prices can be found in figure 49. When a calculation is made for the ten displays that will be made in the future, the costs of the parts can be lowered because larger numbers give a good negotiating position for a reduction on the price. A average reduction of 15% is used in this calculation. An overview is given in figure 50.

Part	*Number*	*Price*	*Total*
Wood	1 (244 x 122 cm)	$15.00	$ 15.00
Portable DVD player	1 (10.2")	$ 200.00	$ 200.00
Poster	6 (A3)	$ 6	$ 36
2 components glue	2	$ 6	$ 12
Hinge	2	$ 2	$ 4
Screws, nails, etc	-	$ 10	$ 10
Labor costs	32 hours	$ 1 per hour	$ 32
Total			Estimated around $ 300

Fig. 49 Production costs for one display

Part	*Number*	*Price*	*Total*
Wood	1 (244 x 122 cm)	$12.75	$ 12.75
Portable DVD player	1 (10.2")	$ 170.00	$ 170.00
Poster	6 (A3)	$ 5	$ 30
2 components glue	2	$ 6	$ 12
Hinge	2	$ 2	$ 4
Screws, nails, etc	-	$ 10	$ 10
Labor costs	32 hours	$ 1 per hour	$ 32
Total			Estimated around $ 260

Fig. 50 Production costs for a display produced in a series of ten

8.9 Conclusion

The final design of the display is a product that meets all the main criteria, which makes it a very complete design. This is also accomplished because there was a tight cooperation with the designers of the shop and the solar home system. The test results of the posters were also very promising.
The integrated television screen isn't only useful for the animation and promotional video. It creates many options for future promotional or educational ideas. And the final design is within the budget of Kamworks and can be produced in their own workshop.

Discussion

The discussion of this project is divided into three different categories; the research phase, design phase and overall process.

Research phase

The research phase covered about one third of the total project time. This resulted in an extensive analysis about Cambodia. This might seem a bit overdone and not always relevant for an assignment of three months, but in the end I realized that all this information made the execution of this assignment a smooth process. This resulted in a design that is in line with the Cambodian culture.
The research phase was executed in the Netherlands and made it hard to do a market research. Once in Cambodia there was little time and many new factors for this project. This resulted in a short market research than planned. Fortunately the solar home system is a relative new product on the rural market of Cambodia so this didn't had too many consequences for the outcome of the project.
Literature on the situation in Cambodia, especially the energy situation was rare and mostly a couple years old. After living for a period in Cambodia it became clear that the information from the literature wasn't always reliable. This made it hard to draw conclusions based on the literature. I tried to combine the information in the literature with my own experiences and experiences of my fellow students in order to make the right decisions for the project.

Design phase

The concept phase was relatively short, because there had to be enough time to make and test the final design. Because the research phase was extensive the concept phase could be shortened. The criteria that the concept had to fulfill were very clear and made it possible to make a quick decision. This resulted in a very complete design. Unfortunately the possibilities for an interactive concept were lowered because of the difficulties to buy the right components in Cambodia and the limited options in guidance for this specialty, because there were so many students in that period. Making the model was a labour-intensive project, because of the lack in right tools and guidance. The alternative methods to make the model were very time consuming.

Process

In the overall process I sometimes found it hard to make all the decisions concerning the project on my own. The company kept all the options open by letting the students make almost all decisions, where in my opinion a good discussion between student and company could have lead to new ideas. On the other hand, the situation in Cambodia was very ideal for all the students to work together. With regularity I would team up with Kirsten Rijke and Tom van Diessen, who's projects were overlapping with my project.
The work situation was sometimes hard with no own workspace, rarely any internet and an overcrowded house / office.

Recommendations

There are some points of the concept that can be improved before the first series of information displays are produced. The model information display is made of MDF, because this was easy to get in Cambodia and easy to shape with the tools available in the workshop of Kamworks. A big drawback of MDF in this situation is that water can make the MDF swell and break. Because the Kamunasal shops are open during the day and the information display is placed on a side wall the heavy rains that are common in Cambodia in the rainy season can damage the display. When the model is placed in one of the shops the effect of the rain and high density of the air must be tested and if it damages the information display it is better to use another type of wood for the first series.
There is no integrated sound system in the model, the sound comes out of the speakers of the portable DVD-player. This situation is far from ideal, because the sound of the DVD-player's speakers produces a meager sound. There should be some research in a good but small sound system that can be placed inside the cabin under the portable DVD-player. Another option could be to connect a larger sound system with a long cable to the DVD-player and place this outside the information display.
The whole model is made out of MDF with a thickness of 18 mm. For a more define information display some parts could be made of thinner wood. For example, the door with the integrated television screen, which would make transition between the screen and door much smoother. Also there would be more time for a good finishing of the information display.
Besides some optional improvements, there are also several possibilities that are created by the information display. The integrated television screen can be used for all types of promotional or educational movies. So not only the solar home system, but also other products from the Kamunasal shop can be presented on the screen.
The graphics on the posters of the information display can also be used in other promotional or educational communication of Kamunasal, like a brochure. And the song that is developed and will be used in the commercial with a famous Cambodian singer could also be used for different commercial objectives. An idea is to make a karaoke version of this song, because this is very popular in Cambodia and make this a give-away for the Kamunasal shop keepers.
On of the worries I have after this project is that the marketing of the solar home system might not be solid. The electricity grid is growing fast around Phnom Penh, exactly the area where Kamworks wants to sell the solar home systems. But most Cambodians addressed that they would rather use electricity grid than a solar home system when possible. And because the solar home system is meant for the social class that can afford the inexhaustible source of electricity from a grid connection with a spread investment, the exhaustible source of electricity with a high investment of a solar home system is not that attractive anymore. This is why I think that the new shops should be placed in more remote areas away from the expanding electricity grid. The solar home system and other solar powered products of Kamunasal are more attractive for potential clients in this area.
Another worry that I have is that the investment of a solar home system is to high for most Cambodians. They don't always understand after explaining that a solar home system is a product that can last several years and can be even cheaper than using a battery. That is why it could be profitable to make a construction where Cambodians can pay in terms instead of all at once.

References

Books

Ball, D.A., McCulloch, W.H. et al. (2008). *International Business: the Challenge of Global Competition.* New York: McGraw-Hill.

Geerligs, T. & Veen, T. van der (2001). *Lesgeven en zelfstandig leren.* Assen: van Gorcum.

Kallenberg, A.J. (2006). *Leren (en) doceren in het hoger onderwijs.* Utrecht: Uitgeverij Lemma BV.

North, P. (2006). *Culture shock Cambodia.* London: Marshall Cavendish Limited.

Ray, N. (2005). *Lonely planet Cambodia.* Hong Kong: Lonely Planet Publications Pty Ltd.

Schutte H., Ciarlante D. (1998). *Consumer behavior in Asia.* New York: New York University Press.

Research rapports

Tun Lean H.E. et al. (2007). *Residential Energy Demand in Rural Areas.* Phnom Penh, Ministry of Industry, Mines and Energy (MIME).

Brun, J., Mahe, J., Chantan, K. (2002). *Photo-Voltaic market development in Cambodia.* Phnom Penh, UNDP project numb. RAS/99/E01.

Cambodian Research Centre for Development (CRCD) (2006). *Feasibility Study of Renewable Energy Options for Rural Electrification in Cambodia.* Phnom Penh, publication reference: EuropeAid/119920/C/SV.

Bachelor and master thesises

Heerdink, J. (2007). *Development of training materials for micro-entrepreneurs in solar energy for rural Cambodia.* Enschede: University of Twente, faculty of Industrial Engineering (internal rapport).

Kranen, M. (2007). *Prototyping, redesing and production plan for the Angkor Light.* Enschede: University of Twente, faculty of Industrial Engineering (internal rapport).

Rijke, K.C. (2008). *Strategy and Design of a Solar Shop in Rural Cambodia.* Delft: University of Delft, faculty of Industrial Engineering (internal rapport).

Websites

Aldus, S. (2000). *How Solar Cells Work.* http://science.howstuffworks.com/solar-cell.htm (15 April 2008).

Central Intelligence Agency (2008). *The World Factbook: Cambodia.* https://www.cia.gov/library/publications/the-world-factbook/geos/cb.html (1 April 2008).

Hofstede, G. (2001). *What are Hofstede's five cultural dimensions?*. http://www.geerthofstede.com (1 April 2008).

References of figures

Fig. 1 Map of Cambodia (page 12)
https://www.cia.gov/library/publications/the-world-factbook/geos/cb.html, visited 10 October 2008.

Fig. 2 Respectively: The King (2008), The Prime Minister (2008) and a popular second job: bus driver (page 12)
Left: http://www.cambodia.gov.kh/unisql1/egov/english/king_new.biography.html, visited 10 October 2008
Middle: http://www.cambodia.gov.kh/unisql1/egov/english/premier.biography.html , visited 10 October 2008.

Fig. 3 Respectively: Cambodian dancers and the opening of the ploughing season (page 13)
Left: http://www.lonelyplanet.com/cambodia, visited 10 October 2008.
Right: http://www.tourismcambodia.com/highlights/events/ploughing_festival.asp, visited 10 October 2008.

Fig. 4 Respectively: Young Cambodian monks and a monk using modern technology (page 15)
Left: http://www.trekearth.com/gallery/Asia/Cambodia/photo25216.htm, visited 10 October 2008.
Right: Photograph of Y. Moekotte (2008)

Fig. 5 Cambodian class (page 15)
http://www.usaid.gov/kh/Photos_Archive.htm, visited 10 October 2008.

Fig. 6 The same word in Khmer and English (page 15)
Graphic design of K. Rijke (2008)

Fig. 7 Scores of Thailand for the five cultural dimensions (page 17)
http://www.geert-hofstede.com/hofstede_thailand.shtml, visited 1 April 2008)

Fig. 8 Average scores of Asia for the five cultural dimensions (page 17)
http://www.geert-hofstede.com/hofstede_thailand.shtml, visited 1 April 2008)

Fig. 9 Electricity prices in Cambodia (page 22)
Tun Lean H.E. et al. (2007). Residential Energy Demand in Rural Areas. Phnom Penh, Ministry of Industry, Mines and Energy (MIME).

Fig. 10 Battery use per social class (page 22)
Tun Lean H.E. et al. (2007). Residential Energy Demand in Rural Areas. Phnom Penh, Ministry of Industry, Mines and Energy (MIME).

Fig. 11 Battery use in Cambodian households (page 22)
Cambodian Research Centre for Development (CRCD) (2006). Feasibility Study of Renewable Energy Options for Rural Electrification in Cambodia. Phnom Penh, publication reference: EuropeAid/119920/C/SV.

Fig. 12 Expenditures on energy compared to total household expenditures (page 23)
Tun Lean H.E. et al. (2007). Residential Energy Demand in Rural Areas. Phnom Penh, Ministry of Industry, Mines and Energy (MIME).

Fig. 13 Overview of costs per energy source (page 24)
Composed by Y. Moekotte

Fig. 14 Atomic structure of silicon (page 26)
http://home.scarlet.be/francis/De%20werking%20van%20de%20zonnecel.htm, visited 15 April 2008.

Fig. 15 Impure silicon with phosphorous (page 26)
http://home.scarlet.be/francis/De%20werking%20van%20de%20zonnecel.htm, visited 15 April 2008.

Fig. 16 Impure silicon with boron (page 26)
http://home.scarlet.be/francis/De%20werking%20van%20de%20zonnecel.htm, visited 15 April 2008.

Fig. 17 Layers of a solar cell (page 26)
http://science.howstuffworks.com/solar-cell.htm/, visited 15 April 2008.

Fig. 18 Monthly average insolation in Cambodia (page 27)
Kranen, M. (2007). Prototyping, redesing and production plan for the Angkor Light. Enschede: University of Twente, faculty of Industrial Engineering (internal rapport).

Fig. 19 Marketing strategy of Cambodian retailers (page 27)
Brun, J., Mahe, J., Chantan, K. (2002). Photo-Voltaic market development in Cambodia. Phnom Penh, UNDP project numb. RAS/99/E01.

Fig. 20 Knowledge on solar energy of battery / TV retailers (page 28)
Brun, J., Mahe, J., Chantan, K. (2002). Photo-Voltaic market development in Cambodia. Phnom Penh, UNDP project numb. RAS/99/E01.

Fig. 21 Promotional material in Cambodia (page 28)
Photographs of Y. Moekotte (2008)

Fig. 22 The kamunasal Solar Home System (page 30)
Render of T. van Diessen (2008)

Fig. 23 Annual costs of a small Solar Home System (page 30)
Composed by Y. Moekotte (2008)

Fig. 24 Annual costs of a large and luxurious Solar Home System (page 31)
Composed by Y. Moekotte (2008)

Fig. 25 User scenario for a medium Solar Home System (page 31)
Composed by Y. Moekotte (2008)

Fig. 26 User scenario for a large or luxurious Solar Home System (page 31)
Composed by Y. Moekotte (2008)

Fig. 27 Rendering of respectively the medium, large and luxurious home box (page 32)
Render of T. van Diessen (2008)

Fig. 28 Adapted hierarchy of needs for Asia (page 35)
[Schütte & Ciarlante, 1999]

Fig. 29 Cycle of learning by Kolb (page 35)
Composed by Y. Moekotte (2008) based on:
Kallenberg, A.J. (2006). Leren (en) doceren in het hoger onderwijs. Utrecht: Uitgeverij Lemma BV.

Fig. 30 Learning process in educational institutes (page 36)
Composed by Y. Moekotte (2008) based on:
Kallenberg, A.J. (2006). Leren (en) doceren in het hoger onderwijs. Utrecht: Uitgeverij Lemma BV.

Fig. 31 Results house visits (page 40)
Composed by Y. Moekotte (2008)

Fig. 32 Respectively a battery of a Cambodian family and a house visit (page 41)
Photographs of Y. Moekotte (2008)

Fig. 33 The micro-entrepreneurs is the solar campus (page 42)
Photograph of D. van der Wouw (2008)

Fig. 34Translation from conclusions to design criteria (page 44)
Composed by Y. Moekotte (2008)

Fig. 35 Idea 1a (page 45)
Drawing of Y. Moekotte (2008)

Fig. 36 Idea 1b (page 45)
Drawing of Y. Moekotte (2008)

Fig. 37 Idea 1c (page 45)
Drawing of Y. Moekotte (2008)

Fig. 38 Concept 2 (page 46)
Drawing of Y. Moekotte (2008)

Fig. 39 Idea 2a (page 46)
Drawing of Y. Moekotte (2008)

Fig. 40 Idea 2b (page 46)
Drawing of Y. Moekotte (2008)

Fig. 41 Idea 3a (page 47)
Drawing of Y. Moekotte (2008)

Fig. 42 Idea 3b (page47)
Drawing of Y. Moekotte (2008)

Fig. 43 Ranking the concepts (page 47)
Composed by Y. Moekotte (2008)

Fig. 44 Exploring main topics (page 49)
Drawing of Y. Moekotte (2008)

Fig. 45 Second round of sketches (page 49)
Drawing of Y. Moekotte (2008)

Fig. 46 The final model of the information display (page 50)
Photograph of Y. Moekotte (2008)

Fig. 47 Two of the families that participated in the test of the posters (page 51)
Photographs of I. Jousma (2008)

Fig. 48 The production of the display in the workshop of Kamworks (page 52)
Photographs of I. Jousma (2008)

Fig. 49 Production costs for one display (page 52)
Composed by Y. Moekotte (2008)

Fig. 50 Production costs for a display produced in a series of ten (page 52)
Composed by Y. Moekotte (2008)

Appendices

Appendix A

Specifications

Medium Solar Home System

Photovoltaic Module (s)	Sharp
Model number	NE-78T1
Type	Poly crystalline Silicon
Number of cells in series	36 cells
Open circuit voltage (Voc)	21.4 V
Short circuit current (Isc)	5.08 A
Rated peak power (Pmax)	78 Wp at STC
V max	17.1 V
I max	4.57 A

Large Solar Home System

Photovoltaic Module (s)	Kyocera
Model number	KC40T
Type	Poly crystalline Silicon
Number of cells in series	36 cells
Open circuit voltage (Voc)	21.7 V
Short circuit current (Isc)	2.65 A
Rated peak power (Pmax)	43Wp at STC
V @max pp	17,4 V
I @maxpp	2.48 A

Luxurious Solar Home System

Model Number	IBT BT 48-12 HC
Nominal voltage	12.0 V
Battery low voltage	9.6 V
Max. Charging Current (Continuous)	12 A
Max. Discharging Current (Continuous)	48 A
Structure and material of positive plate	Lead dioxide
Capacity per battery at C/10 down to 1.75/cell	48 Ah
Self discharge rate	3% / month
Cycle life down to maximum allowable depth of discharge (DOD) of 30 % for lead-acid battery and 50 % for gel type battery of DOD	100% discharge 400 cycles 50% discharge: 750 cycles 30% discharge: 1500 cycles

Appendix B

Questionnaires house visits

House 1
21 April 2008

1. ***What is or are your source(s) of energy?***

They have 5 car batteries, and use 1 or 2 of these so the other ones can be charged in the mean time. All the car batteries are 70 A.

2. ***What kind of electrical devices do you have and use in the house?***

They have 3 tube lights, one for the living area and one for the cooking area. They don't have a TV.

3. ***How long do you use these devices per day?***

They use the lights around 4 hours per day. Sometimes they use candles.

4. ***How often do you change your battery and for how much money?***

Every used battery has to be charged in 2 to 3 days. The costs per battery are 2500 riel.

5. ***How expensive was the battery when bought?***

They bought it for 20 dollar.

6. ***Could you explain how a battery works?***

Don't understand the question, they explain that the battery is very easy in use, but that the place where they can recharge is very far.

7. ***If you are interesting in buying a technical product in a shop, how do you find information about this product?***

They look at the pictures on the box.

8. ***Do you prefer an explanation by text, pictures or a model of the product?***

They like to see how something works on pictures.

9. ***Could you draw a sun?***

The first drawing of the sun is the one with to circles and the diffusion of the light between these circles. This man had difficulties with drawing this sun. With the help of a woman next to him he drew the second sun. They use red to draw a sun and later add some yellow to the orange sun. Someone from the family disagrees and colors orange over the yellow part.

10. ***Could you draw a battery?***

Their own battery is right next to the place we are seated, so they the older woman draws with help of this battery next to her. Both man and woman didn't put a minus and plus on the battery.

11. ***Do you know how solar energy works?***

They know the concept of solar energy, because they saw this at the house of a friend. So they try to draw a solar panel.

12. ***Can you draw a solar home system?***

They can only a solar panel, not the rest of the system.

House 2
21 April 2008

1. ***What is or are your source(s) of energy?***

They use 2 car batteries, one of 40 and one of 50 Ampere.

2. ***What kind of electrical devices do you have and use in the house?***

They have one TV and one tube light.

3. ***How long do you use these devices per day?***

They use the tube light at night and the TV only in rare cases, because it uses so much electricity.

4. ***How often do you change your battery and for how much money?***

One battery lasts one day, since they have two they can use the batteries for 2 days. The charging costs 2000 riel per battery.

5. ***How expensive was the battery when bought?***

They bought it for around 7 dollar.

6. ***Could you explain how a battery works?***

Translator doesn't understand the question. They say the battery is very easy in use.

7. ***If you are interesting in buying a technical product in a shop, how do you find information about this product?***

This family looks at the pictures on the box to understand how a product works.

8. ***Do you prefer an explanation by text, pictures or a model of the product?***

They would rather see a model instead of pictures.

9. ***Could you draw a sun?***

The guy uses green for the whole drawing. He doesn't fully color the sun, he only draws the contours.

10. ***Could you draw a battery?***

The battery is drawn as a square with a positive and negative pole. There are no additional wires or little boxes on top of the battery.

11. ***Do you know how solar energy works?***

They know about solar energy, but there seems to be no more knowledge about this than the existence of it.

12. ***Can you draw a solar home system?***

They say they can't because they have never seen it.

House 3
21 April 2008

1. ***What is or are your source(s) of energy?***

.
They own 2 car batteries, both of 70 Ampere.

2. ***What kind of electrical devices do you have and use in the house?***

They have 1 TV and a total of 6 tube lights.

3. ***How long do you use these devices per day?***

They use the TV and all the 6 lights for four hours in the evening.

4. ***How often do you change your battery and for how much money?***

Every battery has to be charged every 2 to 3 days. This costs about 3000 riel per battery.

5. ***How expensive was the battery when bought?***

They bought it for around 18 dollar.

6. ***Could you explain how a battery works?***

Translator doesn't understand the question. They say the battery is very easy in use, but the place where they can charge is far away.

7. ***If you are interesting in buying a technical product in a shop, how do you find information about this product?***

They look at the pictures on the box to see how a product works.

8. ***Do you prefer an explanation by text, pictures or a model of the product?***

They would rather see a model to see how a product works.

9. ***Could you draw a sun?***

The daughter draws a sun, with the help of a drawing of a sun in a schoolbook. She uses black to make the contours and colors the waves of the sun with orange. She also draws clouds, possibly because there are also clouds on the drawing in the schoolbook.

10. ***Could you draw a battery?***

She draws the battery with help of their battery that stands near.

11. ***Do you know how solar energy works?***

They know that solar energy exists.

12. ***Can you draw a solar home system?***

They don't have enough knowledge about it to draw a solar panel or solar home system.

House 4
21 April 2008

1. ***What is or are your source(s) of energy?***

.
They own 1 car battery of 70 Ampere.

2. ***What kind of electrical devices do you have and use in the house?***

They own 1 TV and have 2 tube lights.

3. ***How long do you use these devices per day?***

They use these devices between 8 and 9 in the evening.

4. ***How often do you change your battery and for how much money?***

The can use the battery for about 2 days and it costs 2000 riel to charge the battery.

5. ***How expensive was the battery when bought?***

They don't remember the exact amount of money they paid, but it was more than 10 dollar, probably 30 dollar.

6. ***Could you explain how a battery works?***

Translator doesn't understand the question. They say the battery is very easy in use and the charging place is near.

7. ***If you are interesting in buying a technical product in a shop, how do you find information about this product?***

They want to see the product itself in the store.

8. ***Do you prefer an explanation by text, pictures or a model of the product?***

They would like to see a working model in a shop.

9. ***Could you draw a sun?***

The son uses green for the whole drawing. At first he doesn't give the sun any waves, but after comment of Pip and the father he puts more effort in drawing the sun. The waves are not just lines, but open.

10. ***Could you draw a battery?***

He draws the battery as a box with a positive and negative pole.

11. ***Do you know how solar energy works?***

They have heard about solar energy, but hey never seen anything that works on solar energy themselves.

12. ***Can you draw a solar home system?***

No, because they have never seen a solar panel or solar home system.

House 5
21 April 2008

1. ***What is or are your source(s) of energy?***

.
They own 2 car batteries, both of 70 Ampere.

2. ***What kind of electrical devices do you have and use in the house?***

They have 1 TV and one tube light.

3. ***How long do you use these devices per day?***

They use everything at the same time and around 2 hours per evening.

4. ***How often do you change your battery and for how much money?***

Every battery has to be charged every week, because they try to save energy. This costs about 2000 riel per battery.

5. ***How expensive was the battery when bought?***

The batteries were bought for around 30 dollar per piece.

6. ***Could you explain how a battery works?***

Translator doesn't understand the question. They say the battery is very easy in use, but the place where they can charge is far away.

7. ***If you are interesting in buying a technical product in a shop, how do you find information about this product?***

They like to see the real product in the shop.

8. ***Do you prefer an explanation by text, pictures or a model of the product?***

If it is not possible to see the real product in the shop they would rather see a model.

9. ***Could you draw a sun?***

The daughter draws a sun with black contours and colors it red inside. The waves are also added in red.

10. ***Could you draw a battery?***

She draws the battery with help of their battery that stands near.

11. ***Do you know how solar energy works?***

They know that a solar home system exists, but they think it is far to expensive for them.

12. ***Can you draw a solar home system?***

They don't have enough knowledge about it to draw a solar panel or solar home system.

House 6
21 April 2008

1. What is or are your source(s) of energy?

.
They own 1 car battery of 70 Ampere.

2. What kind of electrical devices do you have and use in the house?

They have 1 TV and two tube lights.

3. How long do you use these devices per day?

They use everything at the same time and around 1 hour per evening.

4. How often do you change your battery and for how much money?

The battery has to be charged every week, because they try to save energy. This costs about 2000 riel per battery.

5. How expensive was the battery when bought?

The battery was bought for around 50 dollar.

6. Could you explain how a battery works?

Translator doesn't understand the question. They say the battery is very easy in use and the place to charge is near.

7. If you are interesting in buying a technical product in a shop, how do you find information about this product?

They like to see the real product in the shop.

8. Do you prefer an explanation by text, pictures or a model of the product?

If it is not possible to see the real product in the shop they would rather see a model.

9. Could you draw a sun?

Nobody is willing to draw.

10. Could you draw a battery?

Nobody is willing to draw.

11. Do you know how solar energy works?

They say they don't know what solar energy is, but they think we want to sell it to them.

12. Can you draw a solar home system?

They don't want to answer any more questions, because they don't want to buy anything and they think we are sellers.

House 7
22 April 2008

1. What is or are your source(s) of energy?

.
They own 1 car battery of 50 Ampere. Besides the battery they use the generator of their sister to power the TV.

1. What kind of electrical devices do you have and use in the house?

They have one TV and two tube lights.

2. How long do you use these devices per day?

They use the TV one or two hours per day with the electricity of the generator. The lights are on for two to three hours per day with power from the battery.

3. How often do you change your battery and for how much money?

They charge the battery every 3 days and have to go far to charge the battery.

4. How expensive was the battery when bought?

She doesn't know the price of the battery, because she didn't buy it.

5. Could you explain how a battery works?

The battery is easy to use and easy to connect to the devices.

6. If you are interesting in buying a technical product in a shop, how do you find information about this product?

They look at a model of the product in the shop and then decide if they want to buy it.

7. Do you prefer an explanation by text, pictures or a model of the product?

They prefer a model above the other options.

8. Could you draw a sun?

The son is drawing the picture and wants to start with yellow. The younger brother and father comment this choice and he decides to draw the contours with red and fill the sun up with yellow. The waves are a combination of yellow and red.

9. Could you draw a battery?

The son draws the battery with black, quite accurately with a negative and positive pole and a brand name. He also added the voltage on the drawing, but means 70 Ampere instead of 70 V.

10. Do you know how solar energy works?

They heard about solar energy, but they have never seen it.

11. Can you draw a solar home system?

They don't have enough knowledge about a solar home system to be able to draw one.

House 8
22 April 2008

1. What is or are your source(s) of energy?

.
They own 1 car battery of 50 Ampere. They use petroleum for cooking.

1. What kind of electrical devices do you have and use in the house?

They have one TV and one tube light.

2. How long do you use these devices per day?

The TV is broken, so they don't use it any more. They don't have the lights on often, because this saves enery. They seem like a poor family. Sometimes they use candles for light.

3. How often do you change your battery and for how much money?

They charge the battery every 3 days and don't have to go far to charge the battery. The costs for charging the battery is 1500 riel per battery.

4. How expensive was the battery when bought?

They don't remember the price of the battery.

5. Could you explain how a battery works?

The battery is easy to use.

6. If you are interesting in buying a technical product in a shop, how do you find information about this product?

They look at a model or the real product in the shop before they buy anything.

7. Do you prefer an explanation by text, pictures or a model of the product?

They prefer a model above the other options.

8. Could you draw a sun?

They draw mountains first, then a sun. They use green for the contours and color the sun with yellow. The waves are also drawn with yellow.

9. Could you draw a battery?

Remarkable about the battery is that she draws the battery in somewhat 3 dimensions.

10. Do you know how solar energy works?

They heard about solar energy, but they have never seen it.

11. Can you draw a solar home system?

They don't have enough knowledge about a solar home system to be able to draw one. They also don't want to draw anymore.

House 9
22 April 2008

1. What is or are your source(s) of energy?

.
They own 1 car battery of 40 Ampere. They also have one broken battery.

1. What kind of electrical devices do you have and use in the house?

They have one TV and one tube light.

2. How long do you use these devices per day?

They use the lights and TV for 2 hours per day. It is not clear if all the devices are on at the same time for the full two hours.

3. How often do you change your battery and for how much money?

They charge the battery every 3 days and don't have to go far to charge the battery. The costs for charging the battery are 2000 riel per battery.

4. How expensive was the battery when bought?

The battery was bought for 40 dollar.

5. Could you explain how a battery works?

The battery is easy to use.

6. If you are interesting in buying a technical product in a shop, how do you find information about this product?

They look at pictures on the box before they buy anything.

7. Do you prefer an explanation by text, pictures or a model of the product?

They prefer pictures above the other options.

8. Could you draw a sun?

They use only green for the drawing and draw only the contours and waves of the sun.

9. Could you draw a battery?

They draw a simple version of a battery, no poles or brand name.

10. Do you know how solar energy works?

They never heard about solar energy and certainly have never seen it.

11. Can you draw a solar home system?

No.

House 10
22 April 2008

1. What is or are your source(s) of energy?

.

This is a very rich family and they don't use batteries, but have grid-electricity from a generator that supplies in the neighbourhood.

1. What kind of electrical devices do you have and use in the house?

They have one TV, five tube lights and a CD-player.

2. How long do you use these devices per day?

They don't watch TV regularly and have the lights on for about 2 hours per day.

3. How often do you change your battery and for how much money?

They don't have to charge a battery, because they don't have one.

4. How expensive was the battery when bought?

They don't have a battery.

5. Could you explain how a battery works?

-

6. If you are interesting in buying a technical product in a shop, how do you find information about this product?

They look at a model or the real product in the shop before they buy anything.

7. Do you prefer an explanation by text, pictures or a model of the product?

They prefer a model above the other options.

8. Could you draw a sun?

The translator implies that the people in this family are very smart and are willing to draw. They draw far more details that the families in the previous houses. They first draw mountains with black and the contour of the sun with black. The inside of the sun is orange and the waves red. They also added blue clouds.

9. Could you draw a battery?

This takes no effort, they only have to discuss from which brand the battery is. The color yellow is purposely chosen to draw the brand name, so this is probably realistic.

10. Do you know how solar energy works?

They say that they have never heard about solar energy but later turns out that the son can draw a solar panel and the daughter also gives advice on drawing the solar panel.

11. Can you draw a solar home system?

They draw two panels with horizontal lines and wire connection to the battery.

House 11
22 April 2008

1. What is or are your source(s) of energy?

.
This family owns two batteries, one of 50 ampere and one of 70 A.

1. What kind of electrical devices do you have and use in the house?

They have one TV, two tube lights and a CD-player.

2. How long do you use these devices per day?

They use the lights and the TV often. The CD player they use for karaoke.

3. How often do you change your battery and for how much money?

The 50 Ampere battery, they have to charge every 2 days for 1500 riel. The 70 Ampere battery is new and only has to be charged every 10 days.

4. How expensive was the battery when bought?

The 70 Ampere battery was bought for 75 dollar just a few weeks ago.

5. Could you explain how a battery works?

-

6. If you are interesting in buying a technical product in a shop, how do you find information about this product?

They like to see the real product or a model in the shop.

7. Do you prefer an explanation by text, pictures or a model of the product?

They prefer a model above the other options.

8. Could you draw a sun?

The woman says she can't draw, but after a little pushing from the translator she starts drawing, she draws the battery first.
The sun is drawn with a blue contour and a orange inside. The waves are in red.

9. Could you draw a battery?

She draws a battery with the help of another pencil that functions as a ruler. The drawing has a sort of 3D component that you can see the top and the front. She uses bleu and green for the battery.

10. Do you know how solar energy works?

They have never heard about solar energy.

11. Can you draw a solar home system?

They can't because they have never heard about it.

Appendix C

User test posters

Housevisits June 2th 2008
House 1

Rich household, talked to the woman of the house, no other family members except for her 6 years old girl. Woman already received some explaining about solar energy from Tom.

Remarks
She smiles when she looks at the drawings and tries to understand them.
She makes a remark that she thinks the drawings are beautiful. Pip adds that the Cambodians like drawings and pictures.
She skips the titles every time, she only reads the text in black.
Reading takes a very long time, she must really put an effort in reading a piece of text. This is why they probably like pictures above text.
Some posters are not clearly enough about a Solar Home system, so maybe put this in the title to make it clear.

No charging
Top drawing
The woman described the following process according to her interpretation of the top drawing;
The lights and TV get power from the battery. When the battery runs out there is no more light or TV and you need to bring the battery to take the battery for recharging.
At first she didn't realize why the first house didn't have light and TV, but after looking at the other pictures, she understood and also found out that the batteries in the picture have a status of charge (full and empty). She imedialty inderstands that the row of batteries means that the batteries are charging

Text
She finds the text easy to understand and thinks it is in line with the drawings.

Bottom drawing
Even though the battery gets empty, it is possible to use lighting and TV. She understands that the sun charges the battery and that there is a difference between night and day in the drawings. She also inderstands that because the sun charges the battery, they don't have to bring it to the recharge place.
Her idea of the battery in the middle drawing, is that it is almost empty.

Text
She finds the text easy to understand and thinks it is in line with the drawings.

Working
Top drawing
She explains the pictures as following: The solar panel is to store the energy and then is transported to the battery. She understands that the black arrows mean that the battery is charging.

Text
The woman is confused about using the lights at day or night time, because the text seems to say that the lights can only be used at daytime. This needs to be changed.

Bottom drawing
She has a very complete explaination of this part of the poster. She says; "At night time, there is no sunlight, but the energy gets stored in the battery during the day. At night this means she can watch TV and have the lights on.
She also understand that the black arrows mean that the battery gets more empty when you use the energy at night.

Text
She thinks the text fits the image, only the title has the same mistake about using at night an day time. Apparently the title only says something about using at day time.

Cheap
Top drawing
She understands the three phases of the top drawing. At first she has to spend a lot of money to buy a battery. After that the charging costs money again ang again. In total you spend a lot of money.

Text
She understands the text and thinks it fits the drawings.

Bottom drawing
She explains this drawing by drawing. The first represents the money that you need for buying a solar home system. The second that you don't need money for charging. The last one shows that the total amount of money is nearly equal to the money that

you need for buying.
She gets the total message, that a solar home system in the end is cheaper than a battery.

Text
The text gives extra attention to the money saving part, she thinks this is good. Only some letters are missing, because Pip tried to make the text fit the lay-out. This makes it less understandable.

Usage
Top drawing
She doesn't understand this drawing, because she thinks the clocks are little suns. She thins that adding numbers in the clock would make it more clear that this are clocks. Also maybe a change of color, because orange can be seen as a color of the sun.
She thinks that the total of the lamps is respectively 15 and 7 Watt and not every separate lamp. She us suggesting that a 7 Watt lamp needs more sunlight because it uses more energy.

Text
When she reads the text, she understands that the suns are actually clocks and the picture becomes clearer. She only doesn't understand the small text at the end.

Bottom drawing
This picture is clearer, because she already understands the concept from the top drawing. It is better here that there is a difference between the size of the TV, because she immediately understands that the big TV consumes more energy than the small one.
She doesn't understand that the clocks that are only half colored that this represents half an hour.

Text
She doesn't understand the small text at the end.

Quality
Top drawing
The solar panel is from Japan, this means that it is of good quality. She thinks the title can better be advantages (or benefits), because this is what they normally use in this situation

Middle drawing
She doesn't understand what Kamunasal means, because she has never heard of the brand. It is much easier for her to trust the brand because it's from Europe

Bottom drawing
Good service is an advantage for her, because that is not common when buying products in Cambodia.

Easy
Top drawing
She finds 20 year a long time and is really impressed with this number. She thinks that it is better to make the word year in Khmer en not in English.

Middle drawing
She is very enthusiastic about using a star in this graphic, because she thinks a star stands for high quality. "There is nothing higher than a star!"

Bottom drawing
She thinks it is a good idea to put 'no noise' as an advantage on the poster. She thinks this will be an attractive advantage for Cambodians.

Total opinion
She really likes the graphics of the posters and would be attracted by them. She also really likes the idea of the television, because she likes to watch television.
If the product was cheaper she would definitely buy it immediately, because she now understands the product and thinks it has very good advantages.

Housevisits June 2th
House 2

Remarks
There are not many in this family that can read. The test person is the only one at home at this moment that can read.
They are connected to the electricity grid, so the solar home system isn't very useful for them at the moment, but despite this they are very interested in this technology and keep talking about it.
In this house some of the younger family members didn't understand the battery sign in the graphics at first, because they don't use a battery.
The small sun and the bleu line at the top of the poster is mistaken for a sun that is charging.

Cheap
Top drawing
They try to explain the graphic and conclude: When you buy a battery and have to charge it, you spend a lot of money. This validates the meaning of the graphic.

Bottom drawing
When they try to explain this graphic the conclude this: When you get money from the sun, you don't need to spend any money yourself so you save a lot of money for the family. They should see the poster that explains solar energy probably first, before they understand that the sun can charge the battery.

Usage
Top drawing
They explain the picture as following: the energy from the sun is captured by the panel and is stored in the battery. It charges the battery. This means they understand the graphic

Bottom drawing
They fully understand this graphic. Their explanation is that there is no new energy at nighttime because there is no sun. The charging of the battery is only at day time, because then the sun shines. At night we can use the stored energy from the battery that is connected to the lamps and television.

No charging
Top drawing
They misunderstand this graphic, because they think that the battery must be taken to a shop before it can be charged by the sun. But when they read the text, they understand the real meaning of the picture

Bottom drawing
They do understand this graphic, it saves time and money when you use the sun for charging your battery.

Working
Top drawing
They recognize the symbols of the clock and the lamps, but the main idea is not immediately clear for them. It seems that this family doesn't have any idea about electricity consumption. After explaining the basics shortly, they understand the graphics.

Bottom drawing
The concept in this graphic is the same as the top one, so they understand it is the same, but now it represents a television.

Quality
All drawings
He doesn't recognize the logo of Kamunasal and doesn't understand this. But when the text is revealed, he understands it more. With this poster it is always important that the text is read by the potential clients.

Easy
All drawings
According to him the product has good quality and therefore is reliable and makes it a good product for him. It doesn't harm anything or has no impact and has a long lifespan. He finds these very attractive benefits.

Total opinion
He learned a lot from studying the posters. The product has a lot of benefits according to him and he would like to have a solar home system. The only backdraw is the big investment for him, he doesn't have the money to buy a solar home system. He likes the posters and would go into the store to see more of it.

Housevisits June 2th 2008
House 3

Remarks
This is a rich family which would be a good candidate for a solar home system. The mother, the head of the household, can not read, but her daughter can. They use a battery as energy supply and have never heard of solar energy.

Working
Top drawing
Because they have never heard of solar energy this poster causes some commotion in the family at first. The eldest daughter explains it to the rest of the family and after reading the text, it is totally clear.

Bottom drawing
The electricity that is stored in the battery can be used for lamps and a television.

No charging
Top drawing
The charging graphic is not fully clear. When they read the text they understand the process.

Bottom drawing
They get very enthusiastic when they understand that the panel can charge the battery. They ask if they can buy a panel only and use it for their battery.

Cheap
Top drawing
It takes some time before they inderstand the graphic, but after they have studied it thoroughly they get the main idea. Combined with the text it is perfectly clear.

Bottom drawing
After seeing the top drawing and the previous posters they don't need to think twice what this means. They think it is a very good advantage that charging costs no money.

Usage
Top drawing
They have never heard of Wattage and don't understand this graphic. They do recognize lamps and clocks in the drawing. After a short explanation by the text they understand it!

Bottom drawing
This picture is more clear for them because they see the difference between a large and a small television. They understand this.

Easy
Again, the Kamunasal logo is not recognized by the family and they don't understand this drawing. After reading the text they understand this is the name of the solar shop.

Quality
Top drawing
The solar panel is from Japan, which is very good according to the women because this is of good quality.

Middle drawing
After seeing this poster they understand that the panel cannot be used for their battery, but must be combined with the homebox of kamunasal.

Bottom drawing
They understand that a technician can fix technical problems.

Easy
Top drawing
They compare the 20 year guarantee not only with the panel, but also with the battery. This part of the solar home system has a shorter lifespan and doesn't last 20 years.

Bottom drawing
They think it has to have a lot of advantages, because they need to pay a lot of money at once. When they know the price they would compare it to using a battery.

Total opinion
She wants to go to the shop in the near future to get more specific information for their situation. They think service is a very important point.

Appendix D

Brainstorm session with micro-entrepreneurs

How to sell as much as possible:

- Location:
  - market
  - set up branches in remote area
  - open branches where there a lot of people
- Advertising:
  - go directly to tell the villagers
  - go to villager's house and tell them about the products
  - going to village to advertise
  - ask companies and house whether they want the products or not
  - call customers
  - word-of-mouth
  - find places where there are a lot of people
  - advertising through TV, radio, newspaper
  - attract people to know the shop
- Educational:
  - tell the customers about the advantage of the products using solar panels
- Products:
  - sell the products in good quality and reasonable price
  - sell discount in special season
  - maintain them in a good way so as to interest the clients
  - import good quality and effective products
  - when we sell a real goods then a lot of people will buy them
  - sell reasonable prices for meeting the clients needs
- Shopkeeper:
  - train the shopkeeper to know about how to attract the clients
  - choose good shopkeepers who are expert in selling
  - encourage the customers to use the products
  - build confidence in customers
  - issue a name card
  - give awards to people who can attract people to buy the products
- Shop itself:
  - have a comfortable selling place
  - open exhibition room to show the goods

How to make the customer aware of the shop and/or products?

- Advertising
- Big commercial banners
- Location of the shop (place where people can see)
- Giving T-shirt and products to motor taxi (when people see they will know)
- Building confidence in customers
- Opening the training
- Advertising through relatives
- Making customers know about solar panels
- Telling them about location, branches of the shop
- Making sure that the customers know about the products. If not, tell them about quality and advantage of them

Appendix E

Screen options for information display

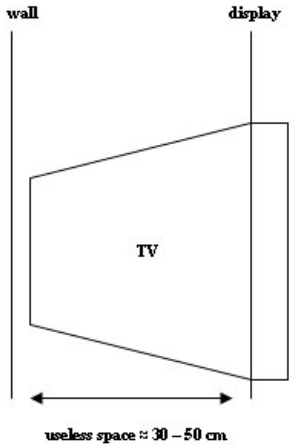
Television

Placing a regular television in the display is not a good idea. Flatscreen televisions are very hard to find and the ones that are available in the shops are very big and expensive.

The normal televisions are not suitable for placing in a display. Since the display is supposed to be at the wall of the shop, the television must be quite flat. The regular televisions are all far from flat. This would cost at least 30 to 40 cm of the space of the shop, because there is useless space behind the display after building in the television.

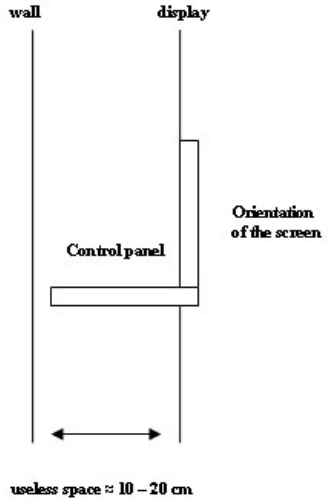
Another problem is that most of the televisions are made for a 220V connection. The battery of the SHS is 12 V and the market is very small for these televisions. Although it is probably possible to place a converter to connect it to a 12V battery, this would make it more expensive.

A great advantage of the regular televisions is that they have a very low price. The average cost lies around 50 to 100 US$ for a new color television. It is unknown how much these televisions use, but the assumption is between 40 and 80 Watt.



Portable DVD players

Portable DVD players are a good option for building in a display, because they are very flat and consume less energy than a normal TV. The disadvantages are that they are more expensive, there are not many different types of DVD players on the market and there is almost always a remote panel that cannot be build in. There are enough types on the market to get a suitable type for the information display that cost less than the maximum price of US$ 200. The best options are described below. They all have the future that the screen can turn 180°, so the remote panel does not stick out of the display. The only remaining disadvantage is that they are all relative small. In terms of attracting people to the shop with the television this might be a problem.



DVD player 1

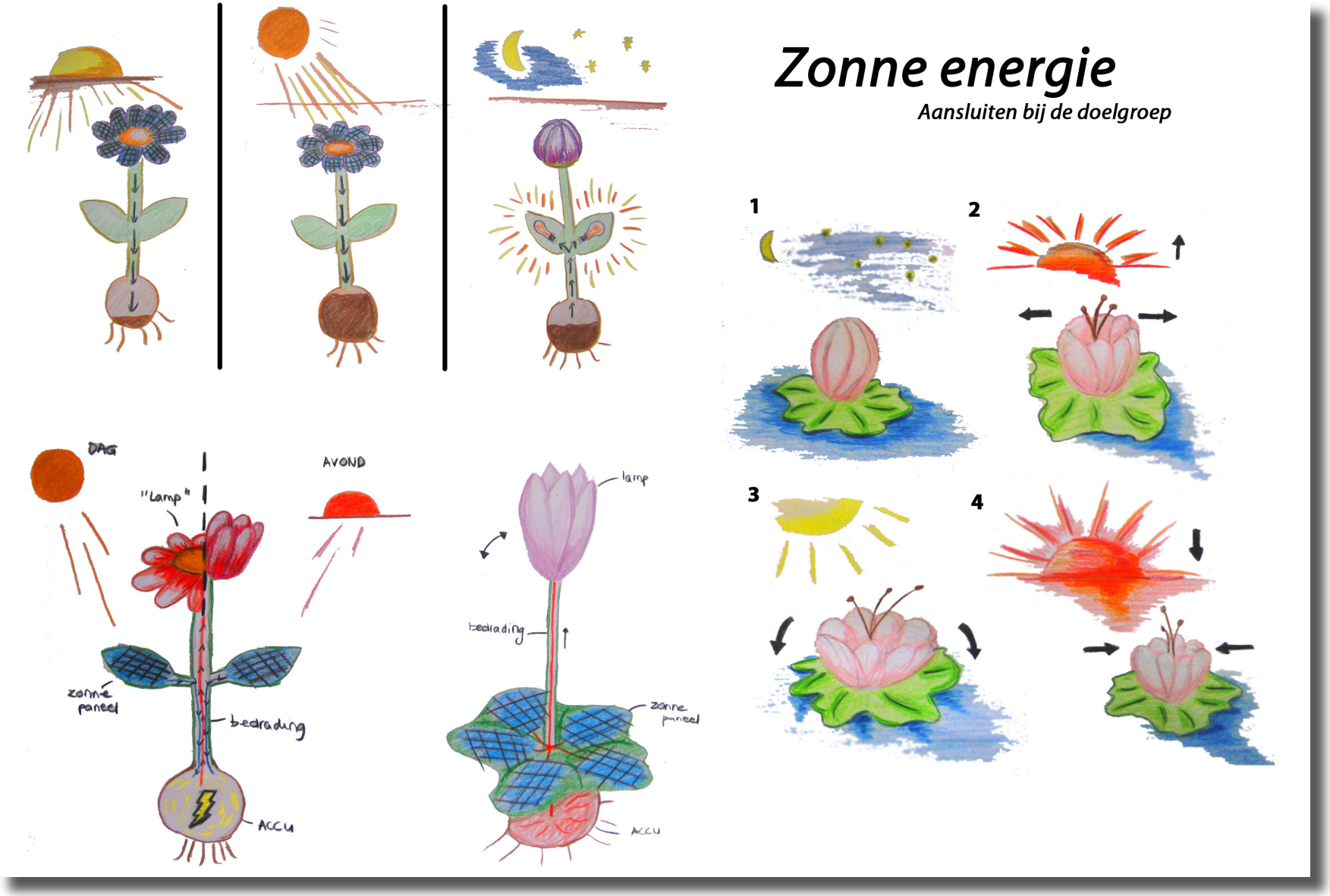
Size: approximately 8 inch
Price: US$ 150
Voltage: 12V
Ampere: Unknown
Energy consumption: unknown
Brand: Sony (new)
Extra: screen can turn 180°

DVD player 2

Size: 10.2 inch
Price: US$ 170
Voltage: 12V
Ampere: 3A
Energy consumption: 36 W
Brand: Sony (new)
Extra: screen can turn 180°

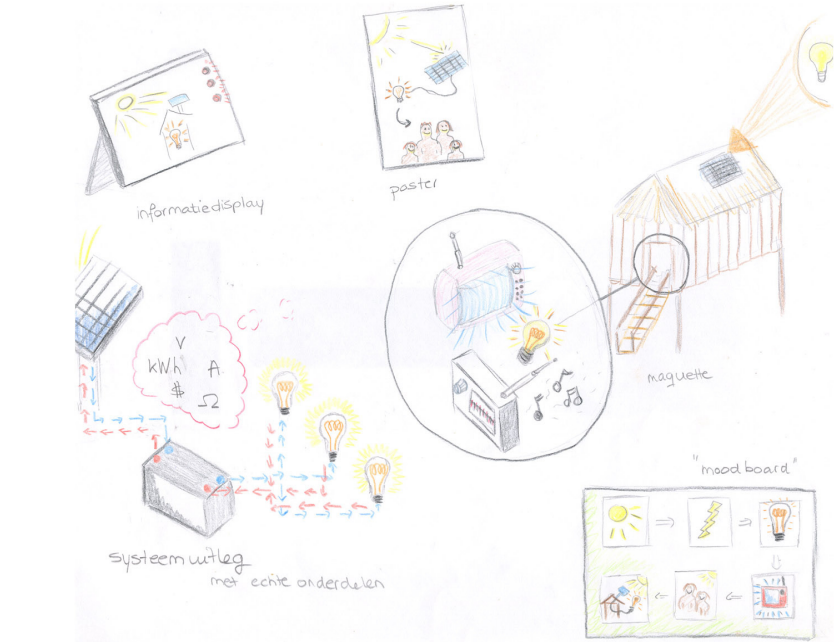
DVD player 3

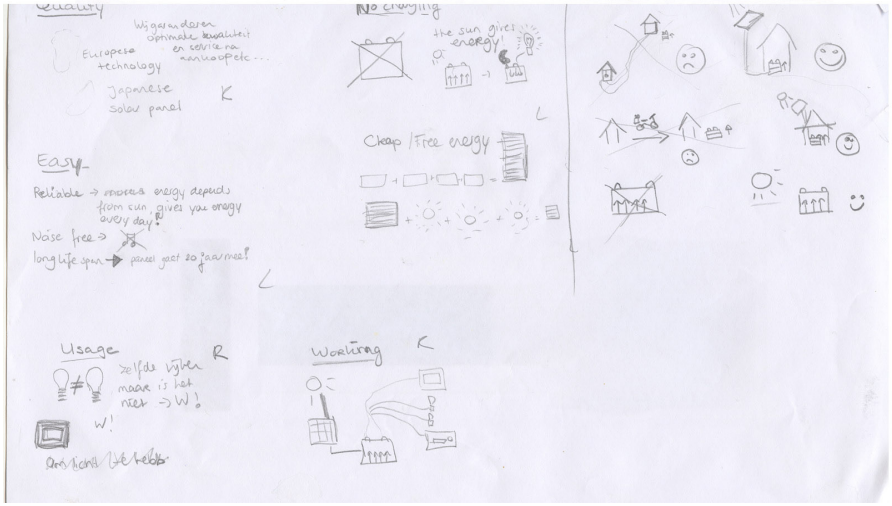
Size: 10.2 inch
Price: US$ 199
Voltage: 12V
Ampere: 2,5 A
Energy consumption: 30 W
Brand: Eurolab (new)
Extra: screen can turn 180°

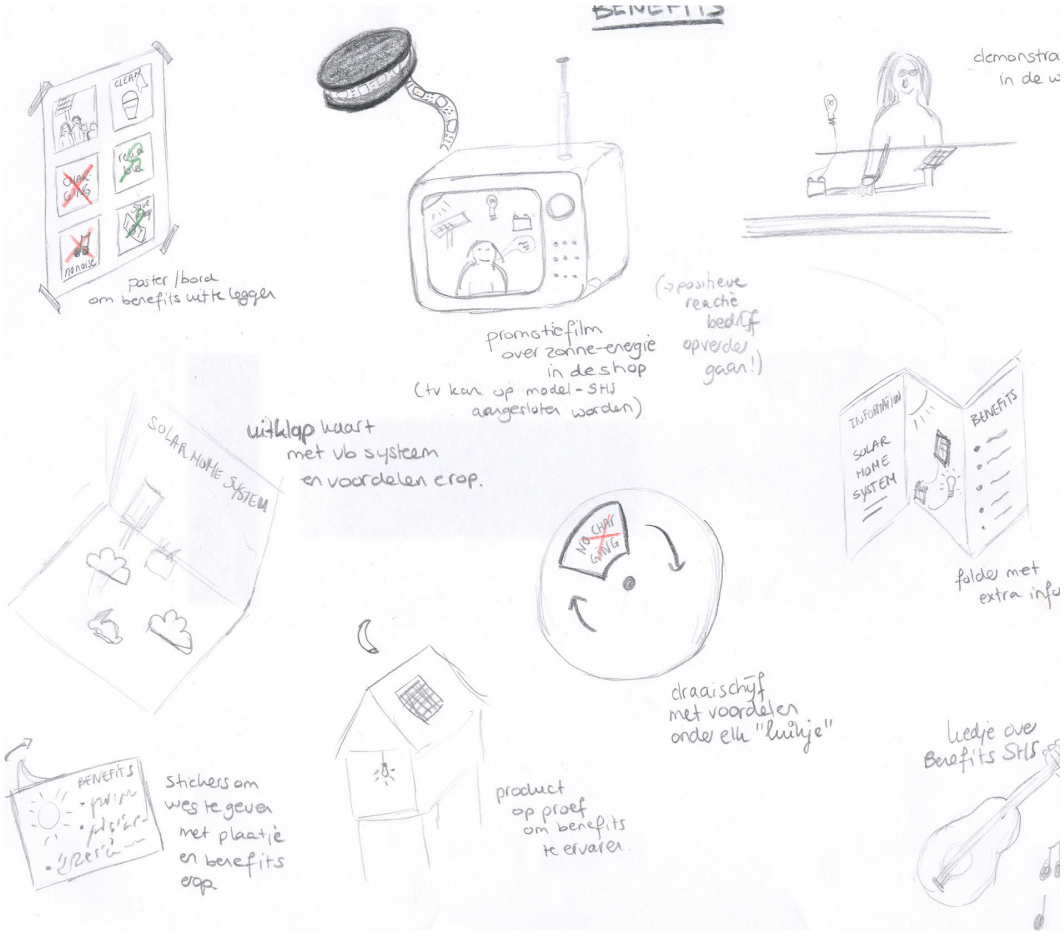

DAG
"Lamp"
AVOND
zonne paneel
bedrading
Accu
lamp
bedrading
zonne paneel
Accu
Zonne energie
Aansluiten bij de doelgroep
1
2
3
4

Appendix G

Idea sketches

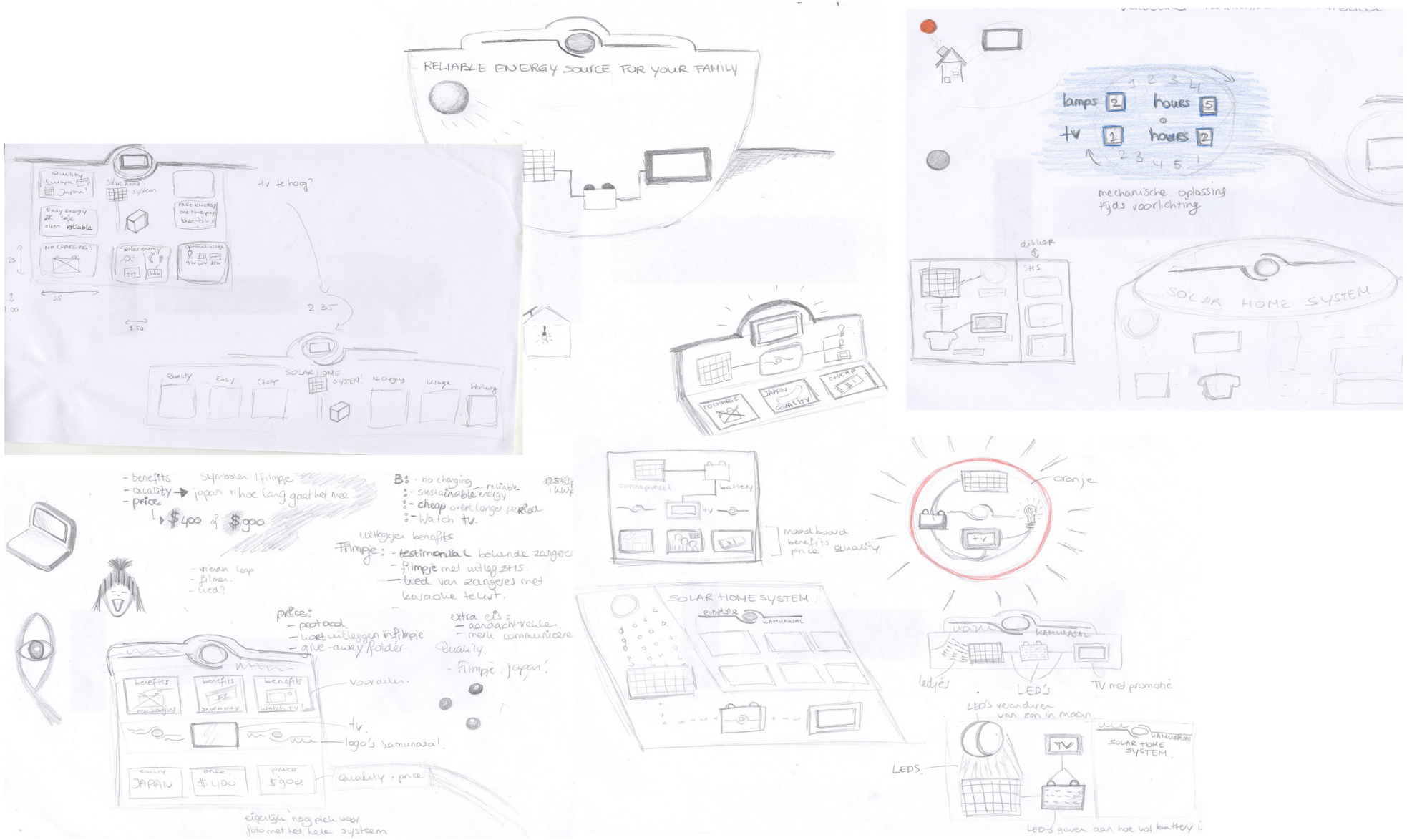






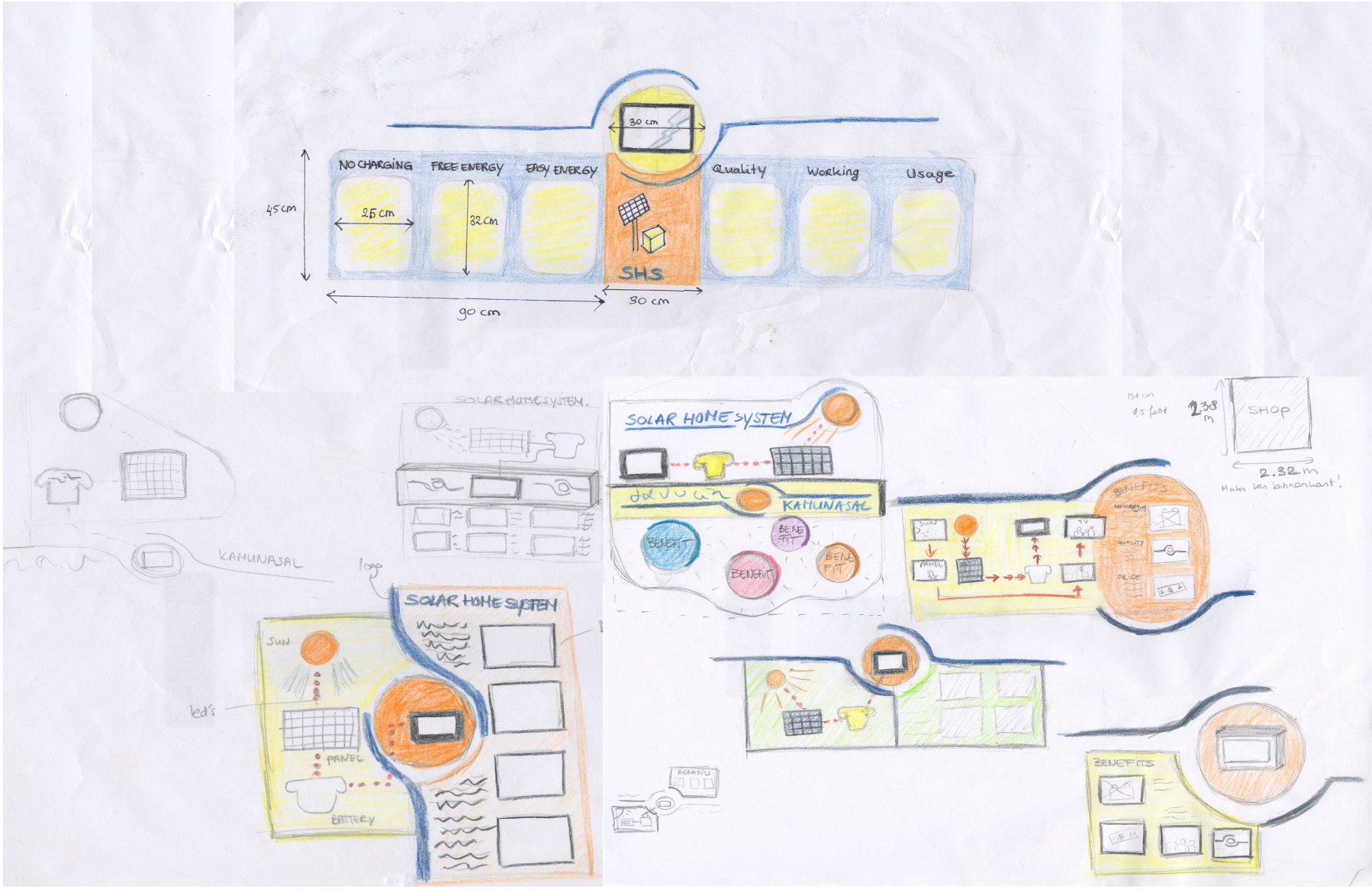
Appendix H

Sketches of a information display



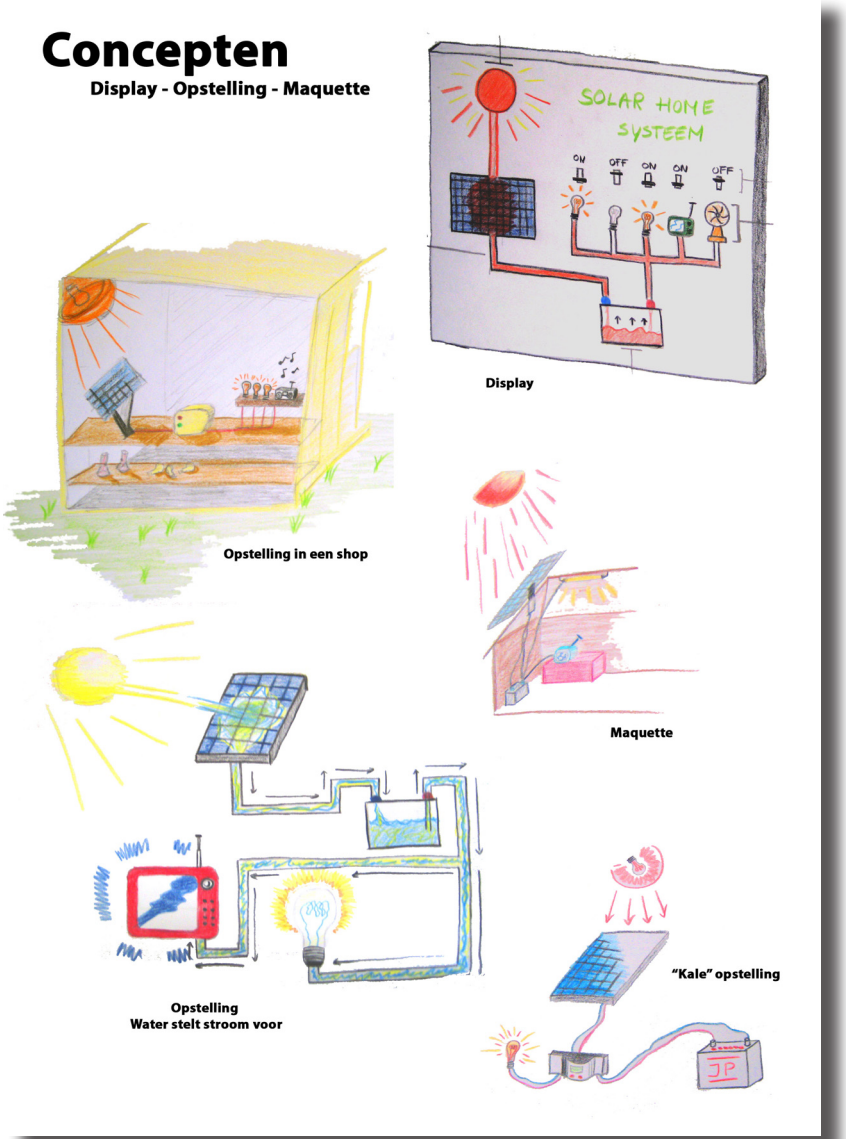
Appendix I

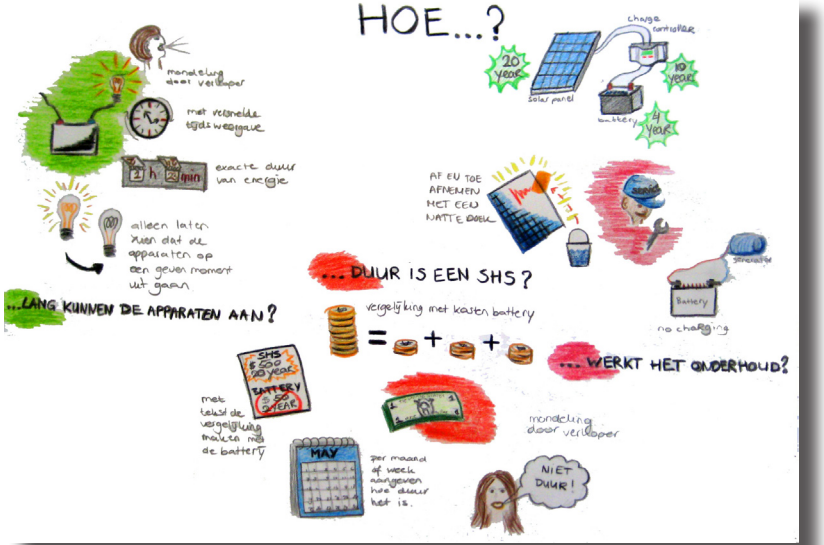
Display concepts

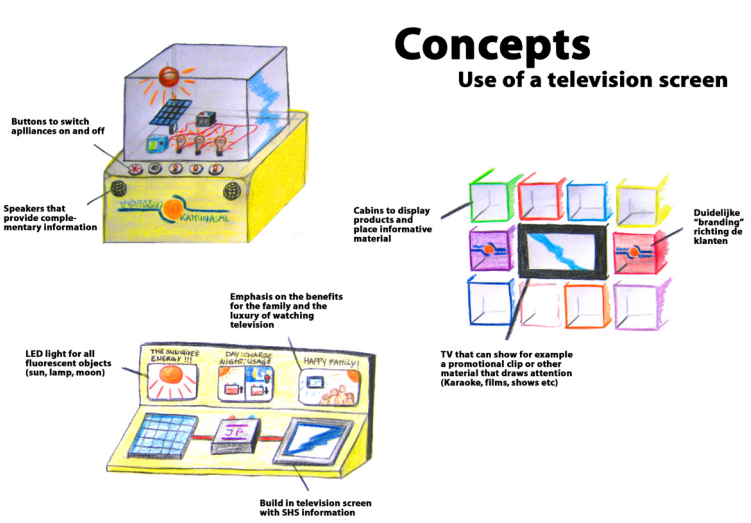


Appendix J

Conceptual drawings

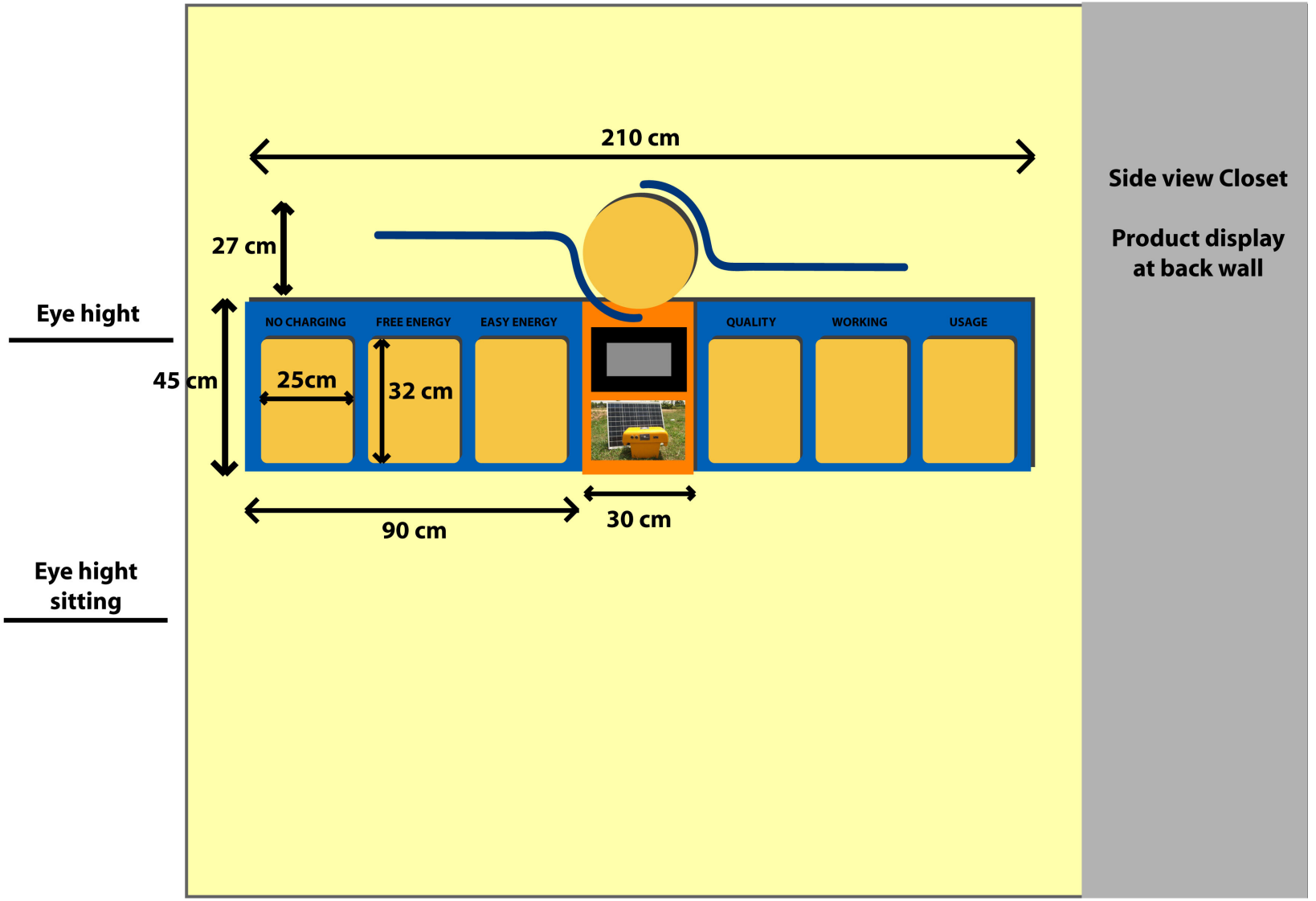






Appendix K

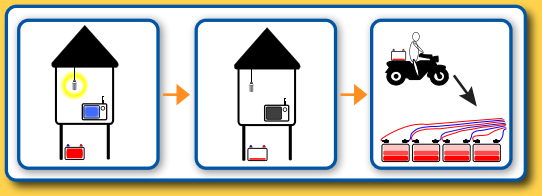
Ergonomic heights of information display



Appendix L

Posters in English

NO CHARGING

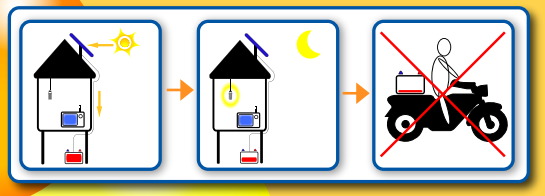


When you use a battery...

You have energy for all your equipment until....

...the battery runs out and there is no other option then...

...bringing your battery all the way to the recharge shop



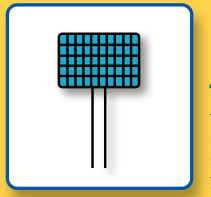
When you use a solar home system!

You have energy supply for all your equipment, because...

... the sun provides new energy for your solar home system...

..and you never have to charge your battery again!

QUALITY



Japanese solar panel

The quality solar panel of the solar home system is made in Japan. The quality of the solar panel is so high that it is guarranteed to last at least 20 years.

European technology

The solar home box is developed by European scientist. It is easy to use and shows you exactly what your energy status is.

Kamunasal service

Whenever something is wrong with your solar home system, our trained staff in the kamunasal shop shall arange help for you.

EASY ENERGY

Long lifespan

The solar panel lasts at least 20 years. This provides you with at least ten years of free energy for you and your family. Enjoy all the benefits of this ground breaking new technology now!

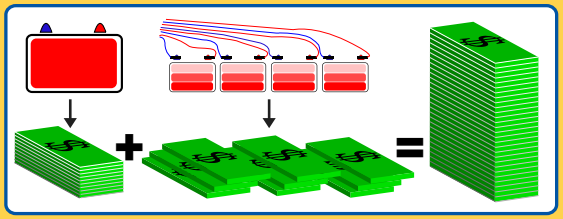
Reliable energy

Kamunasal ensures you a reliable energy source. The sun is your energy provider. The more the sun shines, the more energy you collect in the home box.

Noise free

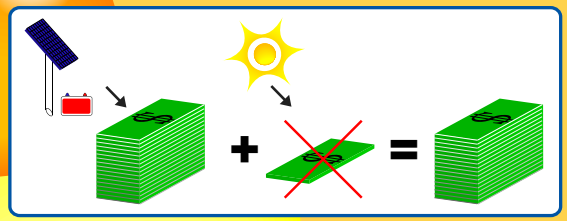
No noise from generating energy. The sun is a very clean and environtment friendly way of retrieving energy. Make the right choice and give youself the luxury of a SHS!

CHEAP ENERGY



Battery

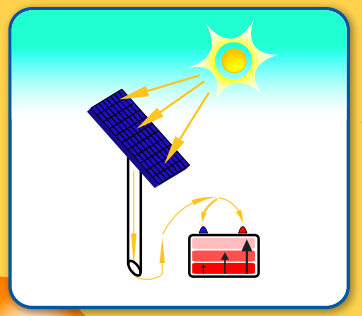
A battery might seem a cheap option for electricity. But when you add up all the costs that you spend on buying and charging your battery it is actually more expensive than a solar home system.



Solar Home System

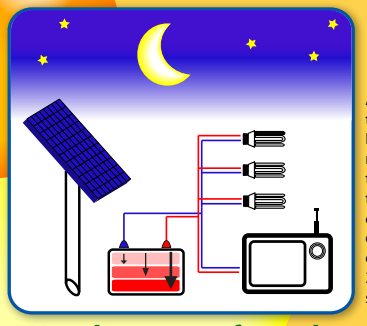
A solar home system requires only a one time investment. After this investment, you will never have to spend any money on charging the system. The sun is your free power supplier!

WORKING



During the day the sunlight shines on the solar panel. The panel converts the sunshine into electricity. The electricity gets stored in the homebox. The longer the sun shines, the more electricity gets stored in the homebox. You can use this electricity througout the day for all your equipment.

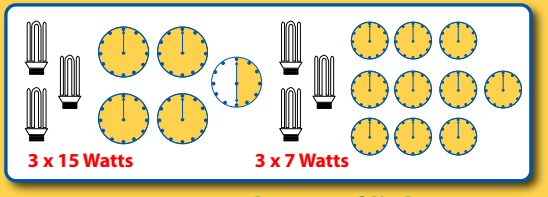
The sun charges your homebox



At night there is no sunlight that shines on the solar panel. During the night there is no new supply of electricity to the homebox. You can use the electricity that was collected during the day. This is enough energy for at least 3 lamps and a small TV.

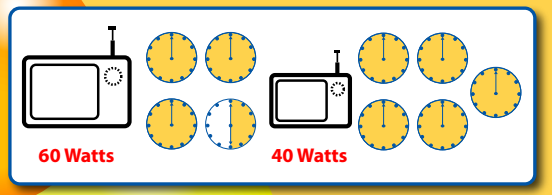
Use the energy from the sun

USAGE



How many hours of light?

There is a lot of difference between lamps that look the same on the outside. If you look on the package of the lamp, you will find the energ usage of the lamp. The less watts the lamps uses, the longer your light can be on during nighttime. (The given hours represent only the usage of 3 lamps)



How many hours of tv?

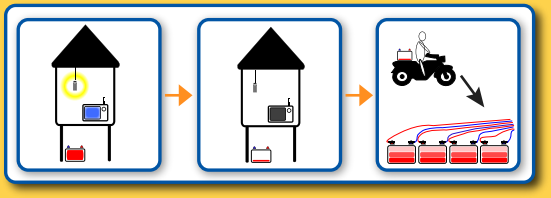
TV's are big energy consumers, so here it is even more important to check the amount of wattage your TV uses. A small black and white TV can be turned on for about five hours. A bigger colour TV can only be turned on for three and a half hours. Check the wattage of your equipment and let the shopkeeper calculate your energy use!

(The given hours represent only the usage of a TV)

Appendix M

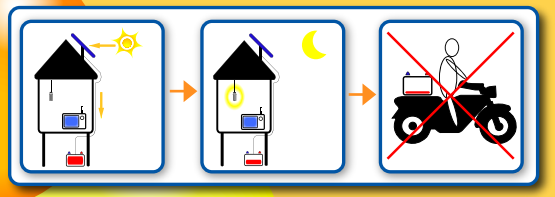
Posters in Khmer

បញ្ឈប់ការសាកអាគុយ



នៅពេលដែលអ្នកប្រើអាគុយ,.....

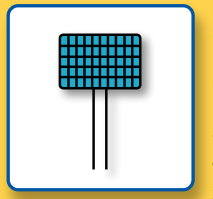
អ្នកមានថាមពលសំរាប ....អាគុយអស់ និងត្រូវចំណាយ ....យកអាគុយរបស់អ្នកទៅ
តបតរណាំទាំងអស់របស់ អ្នក ផ្សេងទៀត បន្ថែមទៀត,... បញ្ចូលម្តង ទៅចំណាង
រួមចប់.....



នៅពេលដែលអ្នកប្រើបន្ទះប្រពន្ធ័ព្រះអាទិត្យដែលនៅក្នុងផ្ទះ !

អ្នកមានភ្លើងត្រប់តបតរណាំទាំងអស់ ....ព្រះអាទិត្យផ្តល់ភ្លើងសារជាថ្មីសំរា ...និងអ្នកចិតចាំតម្លៃបញ្ចូល
របស់អ្នក ពីព្រោះ..... ច់បន្ទះប្រពន្ធ័ព្រះអាទិត្យដែលប្រើនៅ អាគុយចូលទៀតទេ !
ក្នុងផ្ទះរបស់អ្នក...

គុណភាព



ផលិតផលបន្ទះព្រះអាទិត្យមកពី ប្រទេសចិន

គុណភាពរបស់បន្ទះព្រះអាទិត្យរបស់បន្ទះព្រះអាទិត្យដែលប្រើនៅក្នុងផ្ទះគឺ
ផលិតនៅប្រទេសចិន ។ គុណភាពរបស់បន្ទះនេះពីមានគុណភាព
ខ្ពស់ដែលអាចប្រើយ៉ាងហោចណាស់បាន ២០ ឆ្នាំ ។

បច្ចេកទេសមកពីអឺរ៉ុប

ប្រអប់ប្រពន្ធ័ព្រះអាទិត្យដែលបាក់នៅក្នុងផ្ទះគឺផលិតឡើងដោយ
អ្នកវិទ្យាសាស្ត្រអឺរ៉ុប ។ វាមាន ភាពងាយស្រួលក្នុងការ
ប្រើប្រាស់ និងបង្ហាញអ្នកអំពីស្ថានភាពថាមពលដែលអ្នកអាច
ប្រើប្រាស់ ។

សេវាកម្មតួសាល

នៅពេលដែលបន្ទះរបស់អ្នកមានភាពខុសប្រក្រតី បច្ចុប្បន្នដែលមាន
ធ្វើការចុះបញ្ជាលនៅក្នុងចាង កម្មសាល និងជួយអ្នក
ដើម្បីឆ្លើយត្រឡប់ឲ្យ ។

ថាមពលដែលងាយស្រួល

មានអាយុកាលយូរ

បន្ទះព្រះអាទិត្យមានរយៈពេលយូរបំផុតរបស់វា ២០ ឆ្នាំ ។
វាផ្តល់អោយអ្នក និង ត្រួសារបស់អ្នក នូវយ៉ាង ហោចណាស់
នូវថាមពល ដែលមិនអស់អំឡុងរយៈពេល ១០ឆ្នាំ ។
សូមទុកលុយចន្លះដែលប្រយោជន៍ហោយ សប្បាយរីករាយ ជាមួយ
និងចេញថ្មីស្រស់ងាយនេះ !

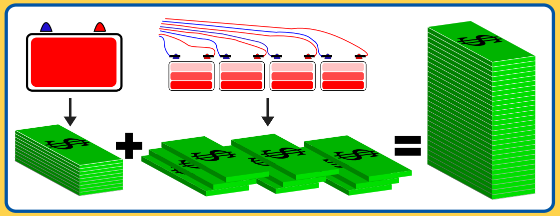
ថាមពលដែលមានការប្រើទុកចិត្តបាន

កម្មវិធីសាលាមានស្ទូរប្រភពថាមពលដែលគួរអោយមានការប្រើទុកចិត្តបាន។
ព្រះអាទិត្យគឺជាអ្នក ផ្តល់ថាមពល ចល់អ្នក ។ នៅពេលដែលបន្ទ
ព្រះអាទិត្យកាន់តែភ្លៅខ្លាំង នោះ ប្រអប់អាគុយព្រះអាទិត្យនិងកាន់តែ
ទទួលបានទូរ ថាមពលកាន់តែច្រើន ។

គ្មានសំលេងរំខាន

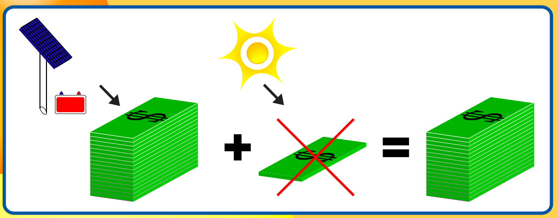
គ្មានសំលេងរំខានពីចាំស៊ុនភ្លើង ។ បន្ទីព្រះអាទិត្យដែលមានភាព
ស្ងាត និងចាំស្ងាត ពីជាចម្បោធយងាយស្រួល ក្នុងការ
ទទួលថាមពល ។ ធ្វើអោយទូរងងប្រើសម៉ីនទូរពីនីន
ត្រឹមត្រូវ និងផ្តល់អោយទូរងង ទូរការប្រើប្រពន្ធ័
ព្រះអាទិត្យនេះ (SHS).

ថាមពលដែលមានតំលៃថោកសមរម្យ



អាគុយ

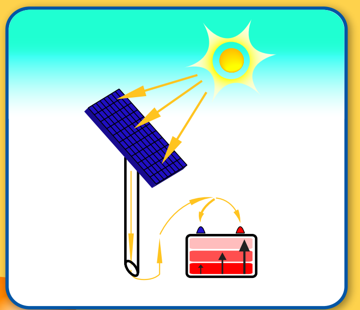
អាគុយអាចមានតំលៃថោកចំពោះអ្នកក្នុងការប្រើភ្លើងអគ្គិសនី ។ ប៉ុន្តែនៅពេលដែលអ្នកបូកតំលៃការចំនាយទាំងអស់ទៅលើ ការទិញ និងការបញ្ចូលអាគុយរបស់អ្នក ជាការពិតណាស់ វាមានតំលៃថ្លៃជាងបន្ទះប្រពន្ធ័ព្រះអាទិត្យដែលប្រើនៅក្នុងផ្ទះ ។



ប្រពន្ធ័ព្រះអាទិត្យដែលដាក់នៅក្នុងផ្ទះ

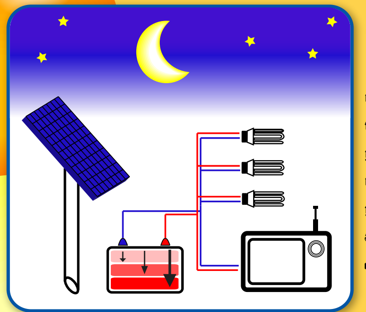
ការវិនិយោគទៅលើបន្ទះប្រពន្ធ័ព្រះអាទិត្យដែលប្រើនៅក្នុងផ្ទះគឺធ្វើការវិយោគតែមួយដងប៉ុណ្ណោះ ។ បន្ទាប់ពីការវិនិយោគនេះ អ្នកមិនចាំបាច់ចំនាយលុយទៀតទេ ក្នុងការបញ្ចូលប្រពន្ធ័នេះ ។ ពន្លឺព្រះអាទិត្យគឺជាថាមពល យើងយកមកប្រើដោយមិនចាំបាច់បង់ថ្លៃ !

ដំណើរការ



នៅកំឡុងពេលថ្ងៃ ពន្លឺព្រះអាទិត្យនឹងជះពន្លឺចំបន្ទះព្រះ អាទិត្យនេះ ។ បន្ទះនេះនឹងបំលែងបន្លឺថ្ងៃទៅជា ភ្លើង ។ ភ្លើងស្តុកទុកនៅក្នុងបន្ទះអាគុយនេះ ។ នៅពេលដែលព្រះអាទិត្យបញ្ចេញពន្លឺថ្ងៃកាន់តែ យូរនោះ ភ្លើងស្តុកនៅ ក្នុងប្រអប់អាគុយ កាន់តែច្រើនដែរ ។ ដូចនេះ អ្នកអាចប្រើភ្លើងនេះនៅពេលថ្ងៃទៅលើឧបករណ៍របស់អ្នក ។

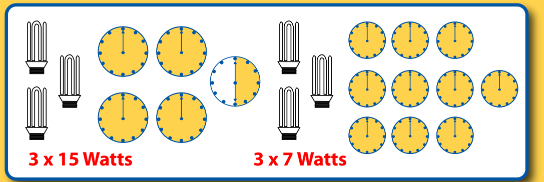
ពន្លឺព្រះអាទិត្យបញ្ចូលថាមពលនៅក្នុងប្រអប់អាគុយរបស់អ្នក



នៅពេលយប់គឺគ្មានពន្លឺព្រះអាទិត្យ ដែលជះមកលើបន្ទះព្រះអាទិត្យទេ ។ នៅពេលយប់គ្មានថាមពលនៅក្នុង ប្រអប់អាគុយរបស់អ្នកទេ ។ អ្នកអាចប្រើថាពលដែលស្តុកទុកនៅក្នុងប្រអប់អាគុយរបស់អ្នក នៅពេលថ្ងៃ ។ វាមានភាពគ្រប់គ្រាប់សំរាប់អំពូលចំនួន ៣ និងទូរទស្សន៍ខ្នាតតូច ។

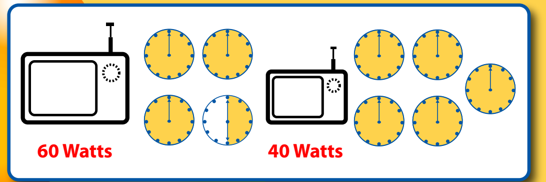
ប្រើថាមពលពីពន្លឺព្រះអាទិត្យ

ការប្រើប្រាស់



តើអាចប្រើប្រាស់ភ្លើងបានប៉ុន្មានម៉ោង ?

មានលក្ខណៈខុសគ្នាយ៉ាងខ្លាំងរវាងអំពូលភ្លើង ដែលមើលទៅដូចគ្នានៅខាងក្រៅ ។ ប្រសិនបើអ្នកមើលទៅលើកញ្ចប់របស់អំពូល អ្នកនឹងមើលឃើញនូវរយៈពេលដែលអ្នកអាចប្រើអំពូលបាន ។ អំពូលដែលមានវ៉ាត់តូច អ្នកអាចប្រើបានយូរនៅពេលយប់ ។ (ម៉ោងឡាស់លាស់បង្ហាញចំពោះតែអំពូលចំនួនបីតែប៉ុណ្ណោះ)



តើអាចប្រើទូរទស្សន៍បានប៉ុន្មានម៉ោង ?

ទូរទស្សន៍ពីស៊ីភ្លើងខ្លាំង ដូចនេះ អ្នកត្រូវធ្វើការពិនិត្យអោយបានច្បាស់ថាវាប្រើចំនួនប៉ុន្មានវ៉ាត់ ។ ចំពោះ ទូរទស្សន៍ស ខ្មៅ ដែលមានទំហំតូច អ្នកប្រើបានរយៈពេលចំនួន ៥ ម៉ោង ។ ចំនែកឯទូរទស្សន៍ព័ណដែលមានទំហំធំ អ្នកប្រើបានប្រហែល ៣ ម៉ោងកន្លះ ។ សូមធ្វើការពិនិត្យនូវចំនួនវ៉ាត់របស់អ្នកហើយ អោយអ្នកលក់ធ្វើការគណនានូវរយៈពេលដែលអ្នកអាចប្រើបាស់បាន ។ (ម៉ោងឡាស់លាស់បង្ហាញចំពោះតែការប្រើប្រាស់ទូរទស្សន៍តែប៉ុណ្ណោះ)

Appendix N

Pictures of the final model of the information display