

Lecture Notes on Solar Cooking





1 General Information

1.1 Ethiopia is a blessed country

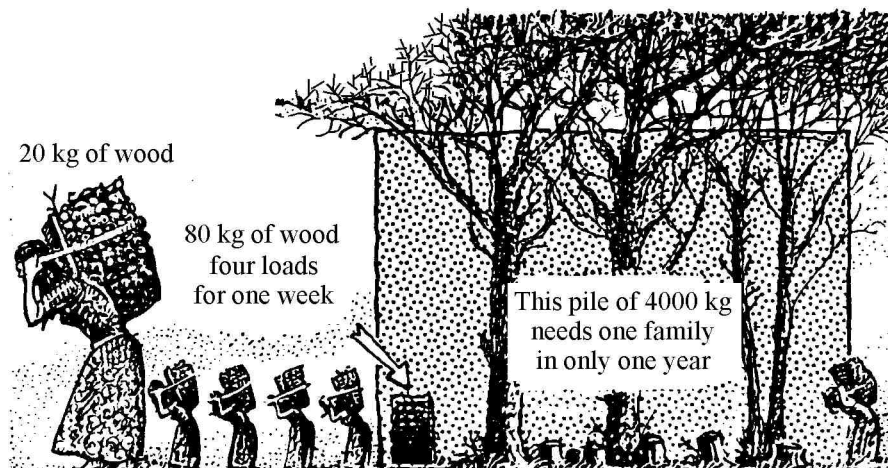
Ethiopia is a country which is blessed with sunshine! The light energy coming from the sun to Ethiopia is so abundant, that the energy would be large enough to supply the whole world with electric power! *Thirteen months of sunshine* is the slogan of the Ethiopian Tourist Organisation and it seems that attracting tourists is the only way this blessing is used at the moment. In fact Ethiopia has *thirteen months of unused sunshine!* More people suffer from sunshine and heat than recognise this blessing and treasure. Ethiopia is a country which is also rich in natural and biological resources and treasures. Thousands of tourists from all over the world are coming every year to enjoy the unique wildlife in Ethiopia, especially in the national parks. There are many animals living in Ethiopia which are unique in the world, like the Simien fox, the Abyssinian Long-claw, the Abyssinian Catbird, the Thick billed Raven and many more. People coming from the financially rich countries are willing to pay a lot just to see the beautiful nature and wildlife in Ethiopia, a treasure they have destroyed in their own countries a long time ago.

1.2 The desert grows every minute

Today every child learns at school how forests influence the climate. Forests play an important role in the water, oxygen, carbon and nitrogen cycles. Trees are able to store large amounts of water between their roots, in the trunk, the branches and leaves. The living roof of leaves provides shade and regulates water evaporation. In the dry season, water is retained because the tree closes its pores in its leaves.

Whenever rainwater falls on land covered with bushes or trees, erosion and flooding is reduced and more water is likely to seep underground, forming pools and springs of fresh water. Without trees, the water of a heavy rain shower flows very quickly down the hills, taking away the fertile soil, making small rivers huge and dangerous, causing mud-streams and floods. Without trees and bushes, there is no shade on the ground, so the sun will dry up the rain again into the clouds. The next heavy rain will come shortly afterwards, and a destructive cycle starts. Erosion mud-streams take Ethiopia's fertile soil, and future, into the sea, killing the people and cattle who destroyed the vegetation, and leaving only dead soil and naked rocks.

The world's forests are rapidly disappearing and even the rich people in the industrialised countries are beginning to worry that they might have already reached the point where it is almost impossible to stop deforestation, either at home or world-wide. In Ethiopia, the wooded areas have been reduced from 40 percent of the country to now only 4 percent in only ten years! This is not enough for firewood and not enough to stop the desert areas in Ethiopia from growing. In large areas even small bushes now have to be used as firewood.





In former times the kings in Ethiopia lost their power and their kingdoms because the land around their capitals, Gondar and Axum, had been destroyed by deforestation. Now with more and more people living in Ethiopia, the disastrous effects of deforestation are a nightmare. And it is becoming a world-wide problem for the whole of mankind. The climate is changing and nature is punishing mankind more and more with catastrophes for this stupid and selfish deeds.

Wood is the primary energy source for 90 percent of the people living in poor countries. Around 1500 million people are cooking or heating with wood. The average family burns about 4 tons of wood a year. About 50 to 70 percent of all the wood used on our earth ends up under someone's cooking pot. Women and children have to spend many hours of the day — possibly the whole day, for nearly their whole life searching for firewood! In the end, they will still have to leave their increasingly waste and destroyed homeland with bad health and damaged bones, fleeing from the desert! In order to survive, these people have to move with their herds to a more habitable land, which means that they have to clear forests again for agriculture, thus starting a new cycle of deforestation and desertification.

It should be understood that population growth is only one reason for this process. Modern agriculture and also many development projects have added to the destruction of the world's forests. Very often new land cannot be found any longer. So villagers move to places where they have relatives to help them. In this way whole villages are slowly moving to escape the desert. These displaced people migrate to the big cities in great numbers. Very few find the better life they were looking for. As urban poor they are worse off than ever. Once in the city the refugees are forced to pay more for wood, charcoal or fuel than for food.

It is true there are other important problems to solve, but deforestation takes Ethiopia's treasures **now and forever!** Erosion will take all fertile farmland into the sea and makes the water salty. There will not be enough for everybody to eat and there will be no way to plant trees again, when the soil is spoiled or washed to the sea. Together with the forest, Ethiopia's rich and unique wildlife and nature will become poor and meaningless. Less water can be kept, the ground water will sink to a greater depth, — droughts in the dry season and floods in the rainy season will become normal, wells will dry up.

There is no doubt that for the survival of humankind the world's forests have to be saved. Deforestation must be stopped. Substantial reforestation has to be undertaken. It is absolutely impossible to get enough trees to grow, to save Ethiopia from this bad future and to have enough firewood at the same time. Reforestation programmes are bound to fail where the people and animals living nearby are in desperate need of fire wood and fodder. There is an urgent need for education, teaching the importance of natural forests. A replacement for firewood has to be found!

1.3 What about Arba Minch?

In Arba Minch the described blessings and problems are very obvious. Sunshine is a gift in Arba Minch throughout the year. Even during the rainy season, there is almost no day without some hours of bright sunshine. There is not much air pollution and the ground elevation is more than 1200 m, so concentrated sunlight energy can be collected. Nature shows its full variety. The Nechisar Park next to Arba Minch is one of Ethiopia's diamonds and almost nowhere in Ethiopia can so many different kinds of birds be found as on the AWTI-compound! It is easy to see zebras, crocodiles, kudus, hippos, hyenas, porcupines, mongoose, Civet- and Genet-cats, warthogs, different snakes, turtles, bushbucks, antelopes, monkeys and all kind of birds close to the town. With some luck you even see pythons and lions right behind the airport.

Arba Minch prepares to become the tourist centre of the south. The new asphalt airstrip is ready, many new shops were built in the last year, a new Commercial bank is under construction and a modern hotel meeting the latest standards of comfort to be built next to Bekele Mola Hotel is on the way. In my country, Germany, people are willing to spend up to 12 000.- Birr for a journey to see the amazing nature around Arba Minch and Jinka, and some of this large amount of money may be spent in Arba Minch, in restaurants, hotels, shops and at the market.

At the same time, the problems of deforestation, erosion and destruction become more and more demanding! Due to soil erosion and degradation, the soil in the high lands can not feed the growing



population of Arba Minch and forces them to settle in the lowlands. But in the lowlands, people are killed by mud-streams due to erosion (40 people died in Arba Minch last year) and high floods have been destroying private and public property, because on the hill sides there is no forest to retain and store the water. Last year the whole village of Lante was under 1.5 m of water and mud, three times; the Kulfo bridge was destroyed by water masses coming from the highlands and many old people, children and cattle drowned when the floods suddenly came at night time.

Firewood becomes more and more expensive in Arba Minch town. With the growing wealth of the inhabitants, the demand for firewood increases. In the last years, more and more firewood has been taken illegally from the unique forests of Nechisar park. Rangers and soldiers started even shooting at the illegal wood cutters, but without much success. Taking wood from the park is a good bargain. A family in Arba Minch had to pay about 1000.- Birr for firewood last year and it will be more next year! The firewood bargain destroys the unique forest around the forty springs. Some years ago it was not possible to see the sky from any place in the forest, in future people will need sun-protection! Only a few more years of wood-cutting and the hundreds of years old treasure of Arba Minch no longer has a chance of recovery.

Deforestation can not be reduced without providing alternatives for cooking which are affordable and acceptable to replace firewood.

1.4 What can be used instead of firewood

Firewood needs many years to grow. The leaves of the trees are collecting the light of the sun and the roots of the tree are borrowing some elements and water from the fertile soil to store the sunlight energy in the trunk. Trees don't take anything from the ground, they only borrow! When wood is burned, the collected sun light becomes hot fire, the water is given back to the clouds and what was borrowed from the soil becomes ashes and can be used again. The same is valid for all plants and animals.

So wood is mainly sunlight, collected over many years!

We might use earth oil products (like gas, fuel, diesel, kerosene, plastic material) or coal instead of wood. But earth oil and coal is made by nature out of trees, plants and animals.

So gas, fuel, kerosene and coal is collected sunlight, made over millions of years!

We might use electricity for cooking instead of wood. Electricity is made by a generator driven by earth oil products, coal, water or wind forces. But all the power for electricity comes from sun light! Sunlight heats the air, producing wind and storm, sunlight lifts the water into the clouds, wind brings the rain to the mountains and water uses the power flowing down the mountains or gives the power to a turbine producing electricity.

So also electricity is always made out of solar energy, — it is collected sunlight.

All life and movement on the earth surface will immediately stop if the sun stops shining. All energy for life on earth comes from the sun. In fact all sunlight shining on Ethiopia brings more energy than all the electric energy all people on earth are using!

So why not use sunlight energy directly for cooking, why burn the treasures of nature? Sunlight is a free gift of God for everybody, for humans, animals and plants. Nobody has to carry heavy loads to collect it, it needs no time or water to grow. There is plenty of sunlight here in the south of Ethiopia even in the rainy seasons, nobody has to wait a long time for it.

1.5 The idea of solar cooking

Using solar energy directly for cooking would immediately help to reduce the need for fire wood. Solar cooking helps to fight deforestation and can improve living conditions at the same time, even in very remote areas. If cooking just using sunlight is possible and people become accustomed to the use of solar cooking, then people could use their time more usefully than for gathering firewood, and Ethiopia would get the chance to become green again, saving nature for a brighter future.

Can this idea ever become true?

Yes it can! A simple solar cooker can be made from a carton and aluminium foil (available in Addis) for less than 30 Birr! This simple cooker needs between 3 and 6 hours for cooking a meal



and the way of cooking has to be different from the traditional way. But the energy is for free. The Solar Initiative at AWTI has developed a high tech parabolic solar cooker based on the German SK 14 which is more expensive but also much more effective than other cookers! This cooker can be used nearly in the same way as for cooking on firewood. It provides a cooking energy of about 600 Watt and all Ethiopian *whots* can be prepared on it in the usual way. Even making (small diameter) *injerra* is possible and it takes only 8 minutes for one litre of water to boil!

For only about 650.- Birr it will save a lot of money and firewood for the next ten or twenty years!



Figure 1: Roasting coffe with the AMSI solar cooker

One solar cooker can meet the daily cooking needs of up to 20 people. Instead of buying firewood, one solar cooker can save about 30.- Birr per week. That means at least more than 1000.- Birr per year could be saved by using the cooker instead of buying fire wood.

Everybody who no longer has to buy fire wood will at least save a lot of time, his health and the beautiful nature of Ethiopia.

Using a solar cooker can help as well with another big problem in some regions: the lack of healthy drinking water. If there is no clean water available, people drink contaminated surface water, which may lead to diseases or even to death. Due to high energy consumption, it is often not possible to boil this water before drinking, which would improve the health situation. But with one solar cooker it is possible to sterilise more than 50 litres of drinking water per day without extra cost or impact on nature!

The cooker is also ideal to distil alcohol from organic matter. This means it can not only be used to produce *caticalla* but also to destil fuel to be used for light and kerosene stoves.

1.6 What does AMSI mean?

AMSI is the abbreviation of *Arba Minch Solar Initiative*. The aim of AMSI is to reduce the deforestation in Arba Minch and the surroundings by promoting the idea of using solar cookers instead of firewood.

AMSI wants to train metal workers in producing the solar cookers and wants to teach interested woman how to handle and use the solar cooker for roasting coffee, making bread and cooking local



food.

AMSI tries to improve the construction of the solar cooker and to import and distribute the mirror material needed for the cooker as far as possible. AMSI was born at AWTI, but as this child of AWTI grows older it should spread the good news in the whole southern region: Cooking with the sun is possible, it is easy and it improves the quality of life.

All members of AMSI are working on a non-profit basis and everybody who wants to support the ideas of AMSI is invited to participate with ideas, teaching and other activities. The parabolic cooker used and promoted by AMSI is based on the solar cooker *EG SOLAR SK 14* developed by the Foreign Aid Group Solar Cooker of the *State Technical College Altötting e. V.* in Germany. This Non-profit Organisation has the aim to spread the idea of solar cooking all over the world by selling model cookers, distributing detailed construction plans and mirror material if not available in the country.

This idea reached AWTI with Mr. Willand from Germany and was encouraged and supported by the environmental club of the Arba Minch Water Technology Institute (AWTI) and the head of the AWTI's metal workshop leader Mr. Muise Gipo. After six month of practical co-operation between Mr. Muise and Mr. Willand, the technique described in the next section has been developed to build the solar cookers using only simple reinforcement bars, which are readily available in Arba Minch.

The developed technique uses simple construction aids made from ply wood to guarantee high accuracy and quality of the cookers and using only few standard tools available in any metal workshop in Arba Minch. With the play wood models, which can easily be copied as well, any good metal worker who is able to do simple welding work is able to produce cookers after only one day of training.

While one model cooker imported from Germany costs 2000.- Birr. The total material cost for one AMSI cooker is less than about 150.- Birr for local material, about 300.- Birr for the mirror material (aluminium sheets) and about 200 Birr for labour costs. The aluminium mirror material for the AMSI cooker has to be imported from Germany at the moment, as aluminium is not produced in Ethiopia. The mirror material for one solar cooker has a package size of $5 \times 15 \times 50$ cm and a weight of 3 kg.

Courses in building solar cookers and construction manuals can be offered by the welding and plumbing work shop at the AWTI.

The solar panel set is available from *Mr. Ralf Wiegand (Kale Heywet Church Arba Minch)*, from *Yamare Solar Energy and Biogas R D (PLC)*, Phone 01-710808, Addis Ababa, or directly from *EG-SOLAR e. V., Neuöttinger Str. 64c, 84503 Altötting, Germany*.

1.7 Technical Data

usable energy	about 600 Watt
maximum temperature	198 degrees
time needed to boil	1 litre in 8 to 10 minutes about 50 litre can be boiled per day
Size	80 cm \times 160 cm \times 160 cm
mirror size	1.4 m diameter, 1.54 m ²
Weight	about 35 kg
price	about 650.- Birr (about 100 US\$)



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