

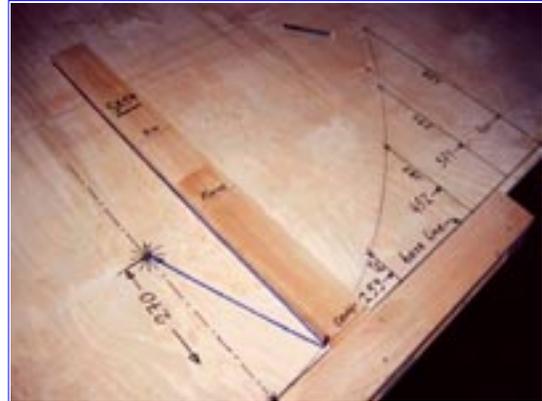


Parabola Design

Wood Model

For the AMSI Solar cooker a simple wood model is used as a tool to assure the exact parabolic shape of the mirror. Precision is very important to get a small focal sun-spot and a high cooking temperature. With an off shape mirror the focal concentration becomes spread and eventually uneven distributed resulting in a cooker which heats up very quickly but does not reach higher temperatures than e.g. 95°C.

To design a parabola I recommend a very simple drawing tool which is able to construct any parabolic curve with ease:



Drawing Tool (click on the pictures to enlarge them) Usage of the Tool

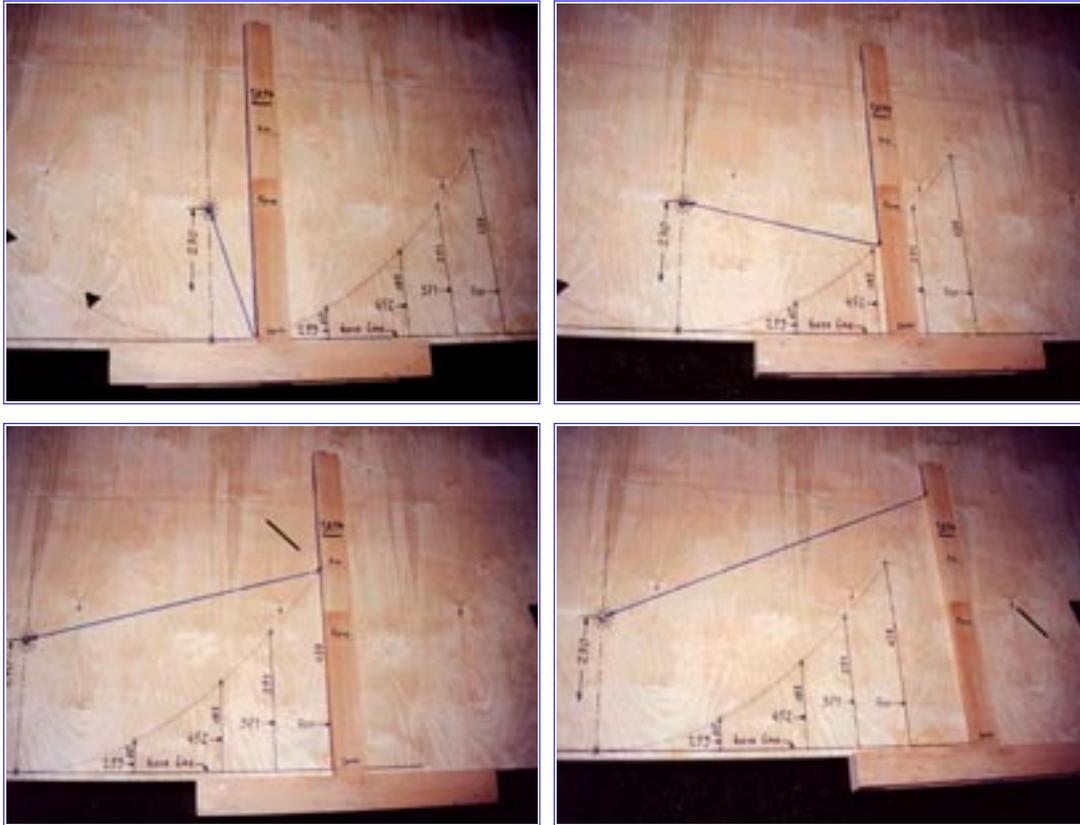
it is a right angle ruler made of wood which can be used for many other purposes as well. At the top of the T-shaped device a string of variable length can be fixed. The string should be made from non elastic material like nylon which does not expand when stressed. The free end of the string holds a little ring or washer.

When put on a table or platewood board the lower horizontal part is pressed against the edge of the table so that the vertical part is always in a right angle to the edge while the tool may slide along the edge line.

Let's take a platewood board with a straight edge at the base and let's press the T-shaped tool now on the platewood edge, so that the vertical part marks the axis of the parabola passing through the focal point. Mark the focal point with a nail or screw on this axis in a distance to the baseline (edge

of the board) equal to the focal distance of the parabola to be constructed.

Hook the string with the ring over the screw at the focal point and place the string along the tolls vertical edge down to the baseline around the tip of a pencil which will later draw the parabola and up along the same edge to the top of the T-tool. Fix the string at the top of the tool so that the string is stiff stretched in this shape. Now sliding the tool to the right and following with the pencils tip the vertical ruler at the T-tool while keeping the string stressed will draw a parabola with the focal distance equal to the distance between the focal point and the start point of the pencils tip. (see pictures below)



click on the pictures to enlarge them.

In this example the focal distance has been chosen to be 270 mm (which is the value for the AMSI cooker and the SK14 and K14 cooker of EG-SOLAR). The other measures marked on the board are not needed to draw the parabola curve, but give the positions of the cage rings for the SK14 cooker and thereby proof that this tool works perfect!

To make the string visible, a blue wool string is used and the pens tip is replaced by a red pin. To draw the curve the wool string should be replaced by something inextendable like a nylon string (e.g. 0,5 mm as used for sea fishing).

It is maybe interesting to mention that string in any drawing position represents as well a ray coming from the sun parallel to the parabola's axis, hitting the parabola mirror and being reflected to the focal point! (Nice! Isn't it?)

If you cut out two pieces of platewood as shown below and put them crosswise together the wood model is ready which can be used as kind of scaffolding and support for the mirror's cage during construction:



click on the picture to enlarge it

The positions where to place the rings are marked by little black triangles. A gap with the same width as the thickness of the plate is cut out along the parabolas axis from the bottom to the mid at one piece and from the top to the middle at the second piece so that the two pieces fit together in a stable position as shown above without glue (see [construction manual](#) section 2.2.2, Figure 3). The model can be taken apart again for storage without effort.



click on the pictures to enlarge them.

Now after making exact rings of sizes as described in the [construction manual](#) (section 2.3.3) they can be placed on the wood model and the connection bars can be bend in a way they touch all the rings without stress before fixing them with wire and welding the cage. The nice thing is that even if a ring is slightly larger or smaller the cage will be still perfectly parabolic.

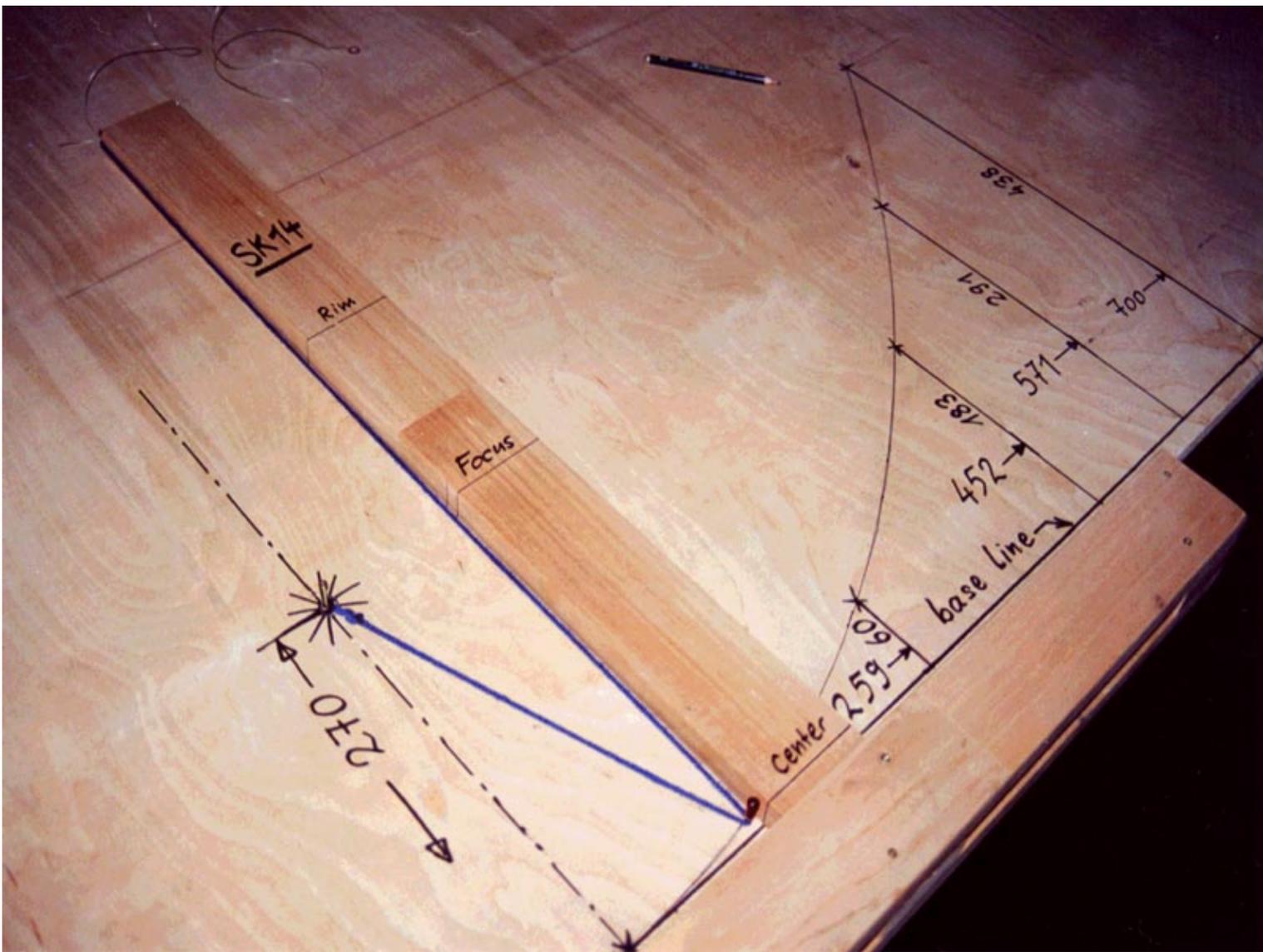
Using a model with eight instead of four 'wings' may be used if the cage should be made from bamboo as a parabolic basket, if reinforcement bars for concrete are too expensive or not available.

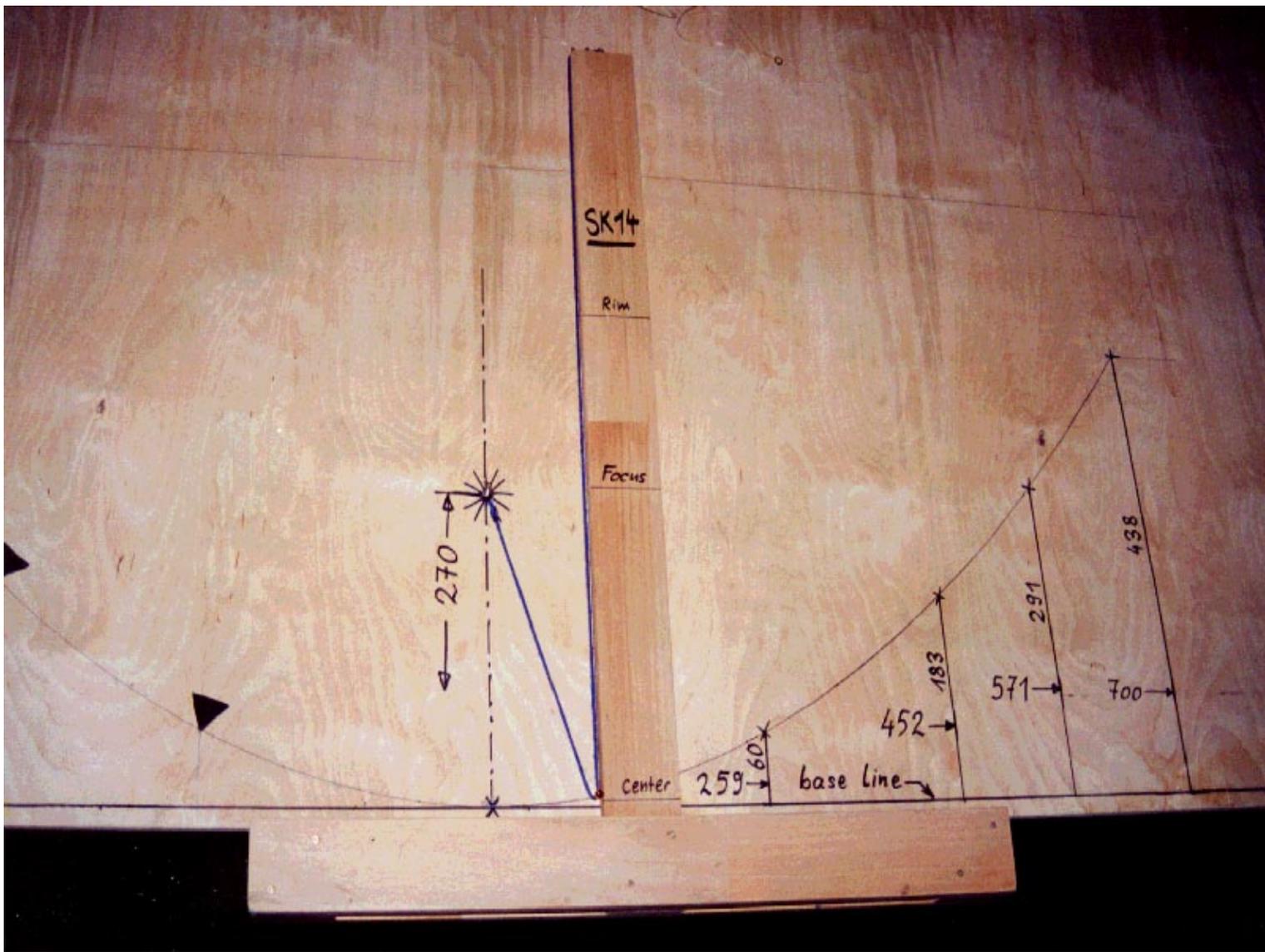
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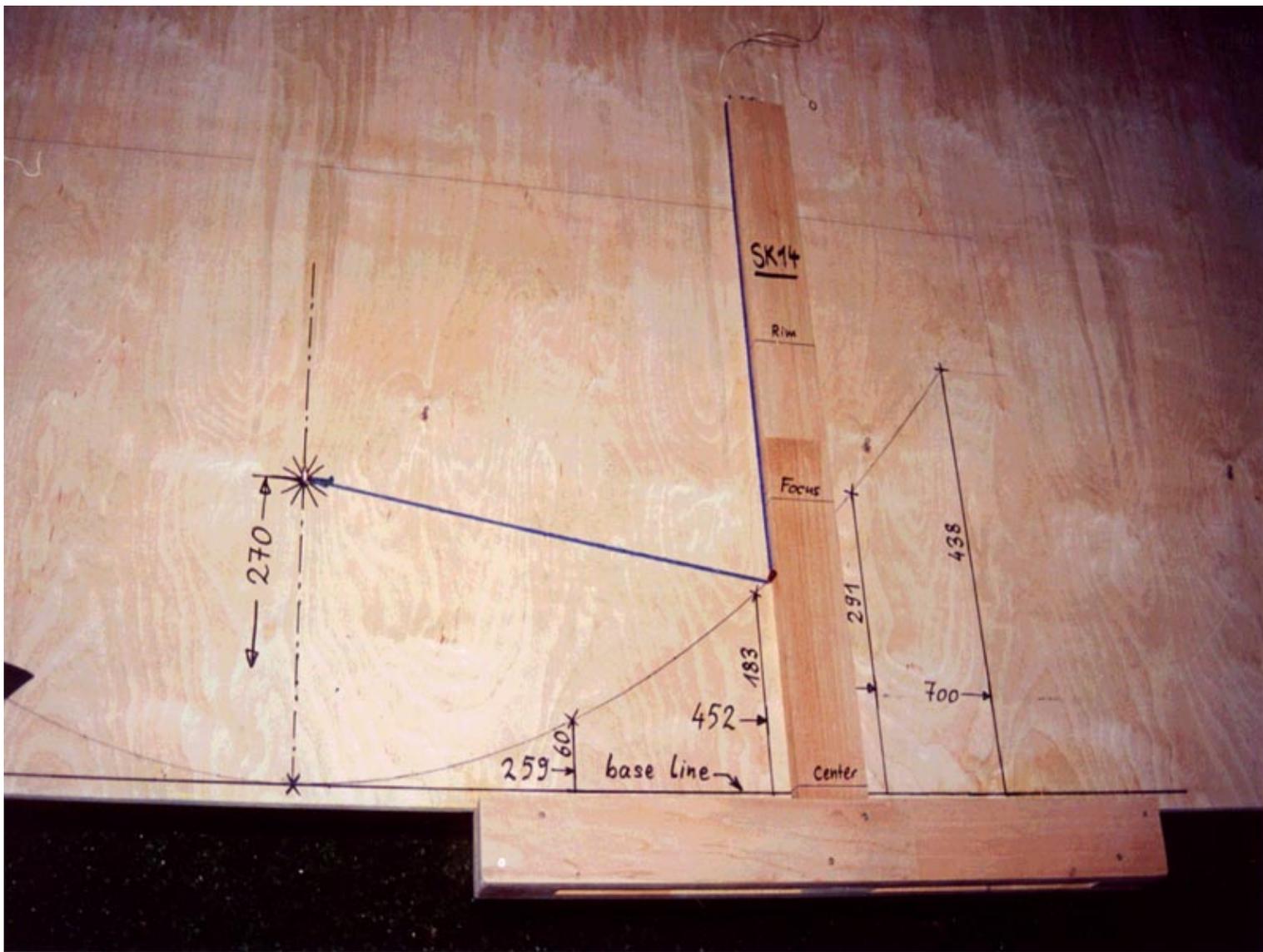
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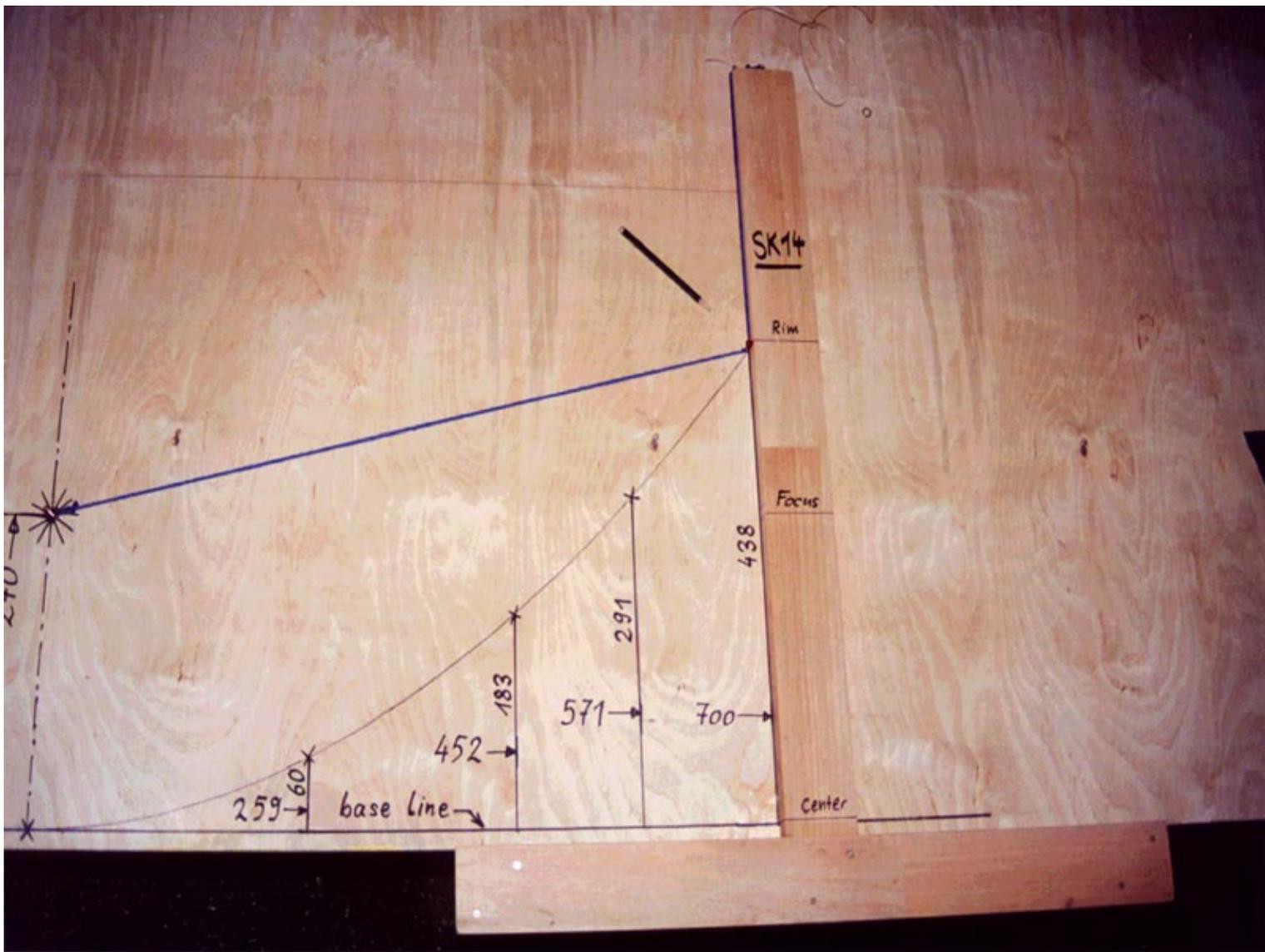


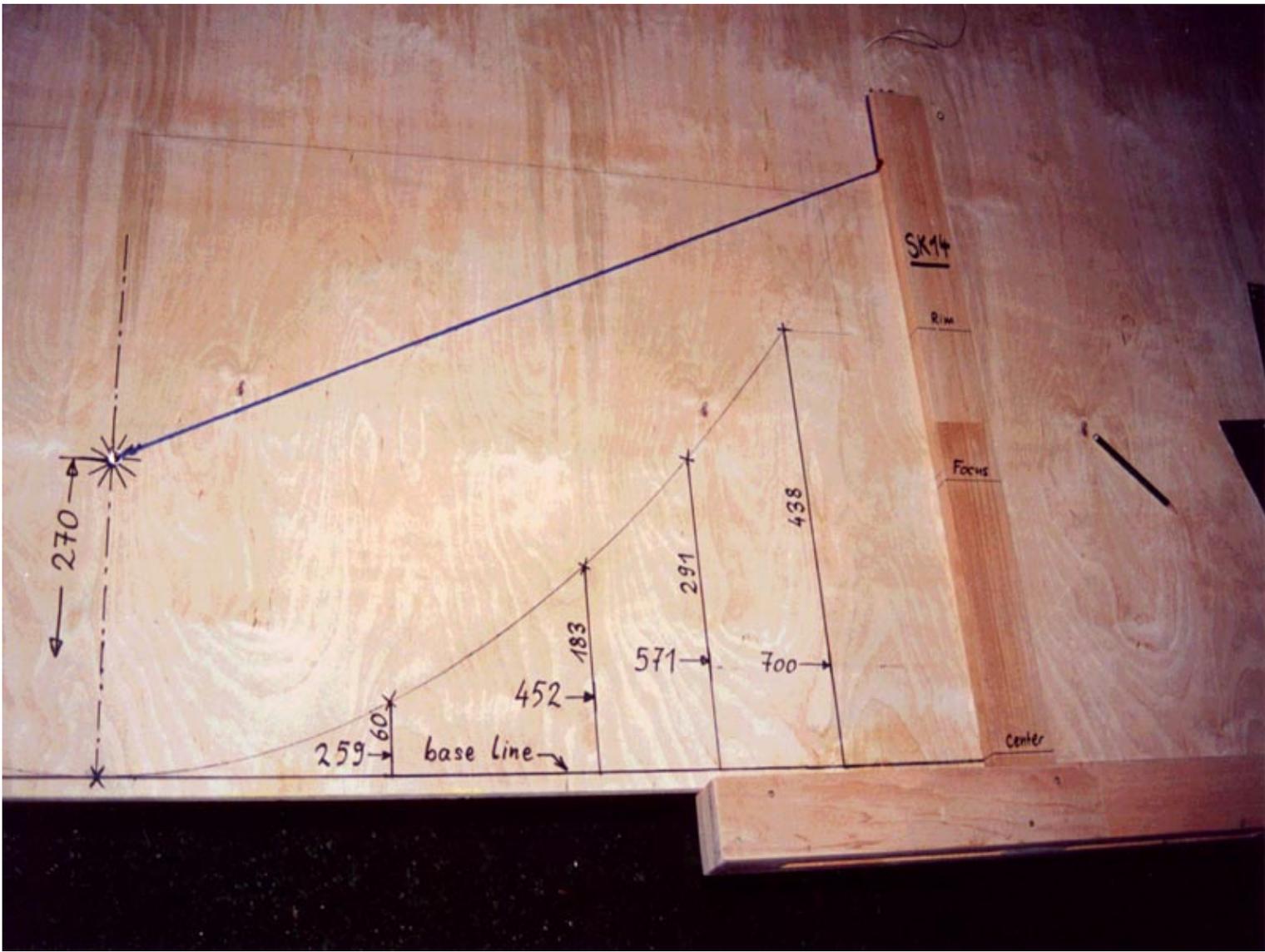


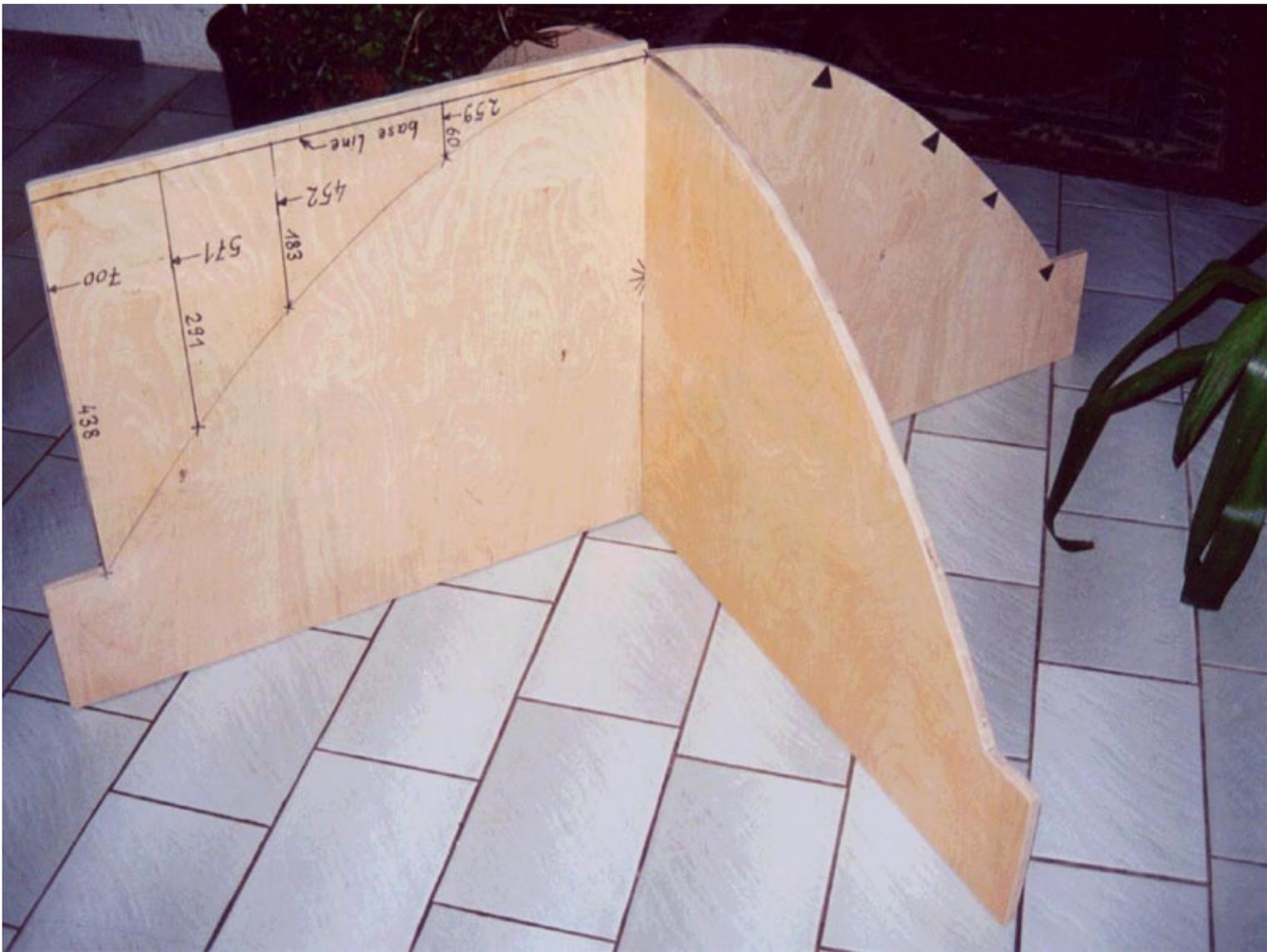














2 How to make the parabolic AMSI solar cooker

It is not really difficult to make your own solar cooker if you have some experiences as metal worker and in welding. But to be successful all work has to be done carefully with **high precision**. This may take a lot of time at the beginning, but if the measurements are not taken accurately and the shape of the parabola cage is somewhat different, than it will be very difficult or impossible to fix the aluminium panels on the cage. If the shape is very bad it will not even be possible to reach the cooking temperature with the cooker!

So take your time, follow the instructions and plans carefully to make already your first cooker a success! **Think that only a good cooker quality is able to spread the idea of solar cooking and if only one bad cooker is sold then this was may be the last cooker produced!**

2.1 Materials needed for one cooker

Most of the material used for the cooker is available in the building material shops of Arba Minch. Not available are the aluminium panels which have to be imported from Germany for the time being. The panels can be bought from Mr. Ralf Wiegand from Kale Heywet Church who has promised to the AMSI on a non-profit basis. An other possibility is to ask Mr. Yamare, Yamare Solar Energy and Biogas R D (PLC), Addis Ababa, Telephone 01-710808 or to import the panels yourself from EG-SOLAR e.V., Neuöttinger Str. 64c, 84503 Altötting, Germany, Telephone 0049-8671-8028, Fax 0049-8671-84689.

The aluminium wire is available in Addis and can be brought by Ralf Wiegand as well, telephone wire should be available in Arba Minch. Rest material can be used as only pieces of about 4 cm length are needed.

Material	Amount
∅ 12 mm reinforcement bar	about 25 m
∅ 8 mm reinforcement bar	about 12.5 m
Sheet metal 150×100×3 mm	2 pieces
Sheet metal 100×100×3 mm	2 pieces
Water pipe 1/2 inch, 100 mm long	2 pieces
Iron wire ∅ 1 mm for temporary fixation	about 3 m
Aluminium wire ∅ 1.5 mm or hard telephone wire	about 8 m
Aluminium panels	36 large 12 small
Welding electrodes	about 20
Anti-rost paint	about 300 ml
White paint	about 200 ml
Metal screw, M 10, about 4 cm long, 3 nuts, 1 washer	1 piece
Big nail or ∅ 5 mm ferro	1 piece
Chord, 3 to 4 mm strong, 75 cm long	2 pieces
Marker for metal or chalk	1 piece
Washing powder to clean the paint brush	some

2.2 Tools needed for the cooker production

The cooker can be produced with the standard equipment of a metal workshop. But it might be somewhat difficult to bend the circles accurately, to cut the 3 mm sheet metall or to drill the four 14 mm holes in the sheet metall. Maybe the already drilled sheet-metal pieces or the rings can be ordered from a better equiped workshop, e.g. at the AWTI's metal workshop.



The work can be done by a single worker, but a helper during welding will speed up the operations.

Tools absolutely needed
Welding mashine, shield and welding hammer Drill machine with \varnothing 14 mm metal-drill (or \varnothing 12 mm and round file) Strong bice, 1.5 m long 1-inch pipe for bending of reinforcement bars Hack saw to cut reinforcement bars Length measure, wire brush, heavy hammer, paint brush, pincers or end-cutting pliers Plane and horizontal place of at least 1.6×1.6 m Platewood-model for the cooker construction (described later)
Tools additionally recommended for enhanced production speed
Circle bending mashine for \varnothing 12 mm ferro Hammer shears for \varnothing 12 mm ferro Table drill press or bench-drill stand Electrical sheet-metal cutter for 3 mm sheet metal Tape measure 10 m Water level Round metal file \varnothing 1 cm and flat metal file Electrical grinding mashine

2.2.1 Preparing the working platform

For the quality control of the circles and the assembly of the cooker it is of great advantage to have an area of at least 1.6×1.6 m which is absolutely **plane and horizontal**. If no concrete floor is available, a stiff platform may be built out of supported plate-wood.

On this platform, the following help-line pattern consisting of one square with 4 concentric circles should be drawn accurate and good visible.

First draw the square and check that both diagonals are equal and 2.25 m long. Find the center, where the diagonals cross and mark it with small nail not completely beaten in. Fix one end of a thin wire on the nail and use it as compasses to draw the four circles with the radius 70 cm, 57 cm, 45 cm and 26 cm.

This platform will be used to check the size and shape of the rings, and to assemble the foot of the cooker.

2.2.2 The plate-wood-model for the cooker assembly

The wood model needs 2 pieces of plate-wood 150×50 cm of the same thickness (e.g. 12 mm). One long side of the plates should be perfect straight or a straight line has to be used as the basis for the parabola construction. The parabola shape with the equation $y = x^2/1120 \text{ mm}$ can be constructes as follows:

1. Draw the y-axis vertical to the long straight side and in the middle of the side.
2. Beginning from this axis mark every 5 cm along the long side into both directions.
3. At these distances to both sides mark the following distances (vertical to the base line and parallel to the y-axis) with a point or little cross.

x [mm]	100	150	200	250	300	350	400	450	500	550	600	650	700	750
y [mm]	9	20	36	56	80	109	143	181	223	270	321	377	438	438

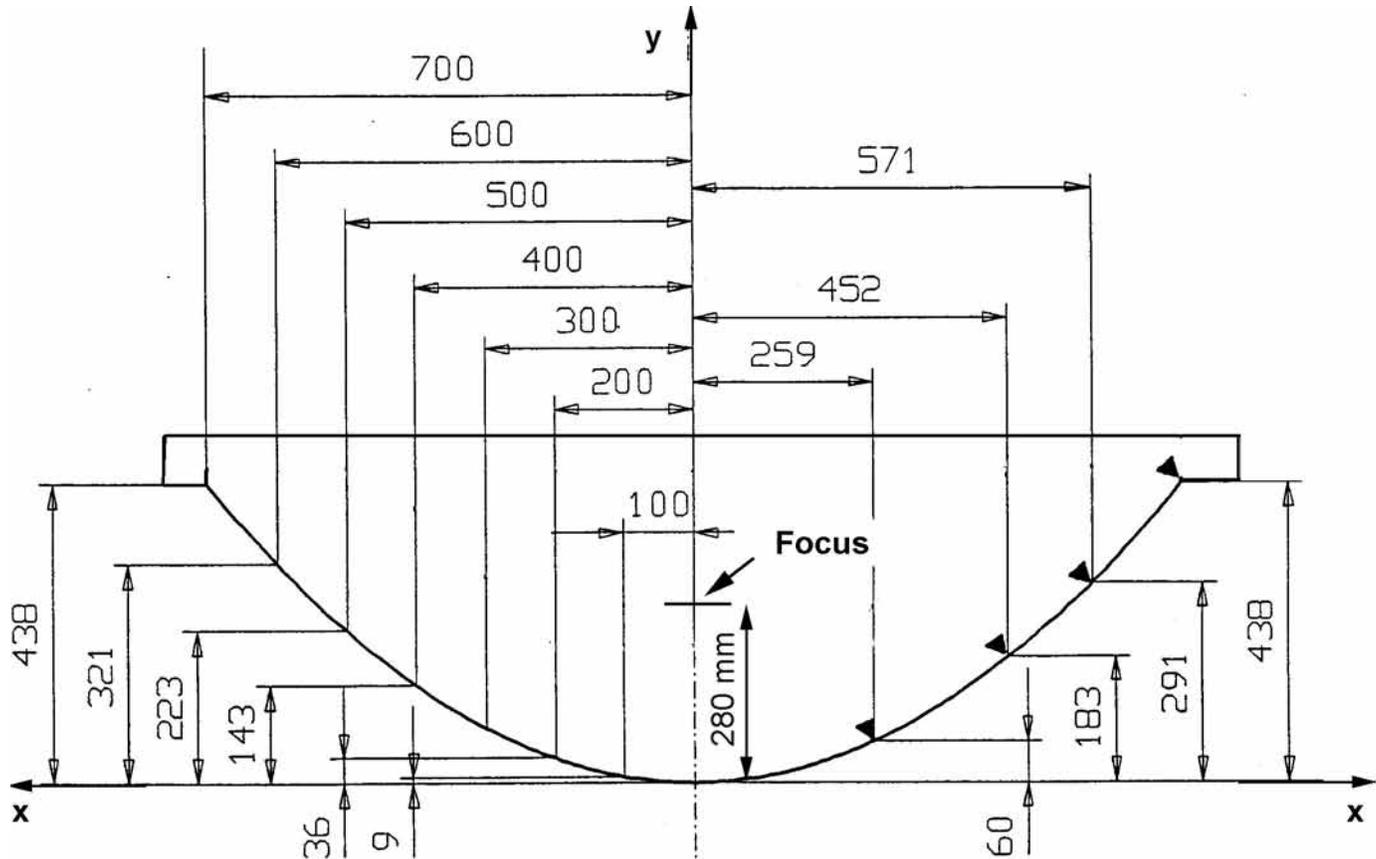


Figure 2: One part of the plate-wood model for the cooker assembly

Connecting these points by a (curved) line gives the shape of the parabola to be cut out.

The measurements in y -direction should be made using a right angle ruler. If no such ruler is available you may cut out a triangular piece of plate-wood with the three sides having a length of 33 cm, 44 cm and 55 cm.

4. On the parabola curve, mark by a black triangle pointing to the curve the following points:

x [mm]	259	454	573	700
y [mm]	60	183	291	438

(see figure 2)

5. Mark the focal point on the y -axis having a distance of 280 mm from the base line by a little line and cut along the parabolic line with a jig-saw (so that the line just stays visible on the model). The model should look then like on figure 2.
6. Repeat the whole procedure for the second piece of plate-wood to have two identical pieces like on figure 2
7. Cut out a strip having the width of the plate-wood along the x -axis from outside in upto the mark for the focal point, for the one piece beginning from the straight base line and for the other piece from the parabolic side to the focal point. Now the two pieces are different as shown on figure 3.
8. Finally the two pieces can be pushed together cross-wise as a complete model of the parabola shape. The arrows are marking the exact positions of the four rings. The model keeps the

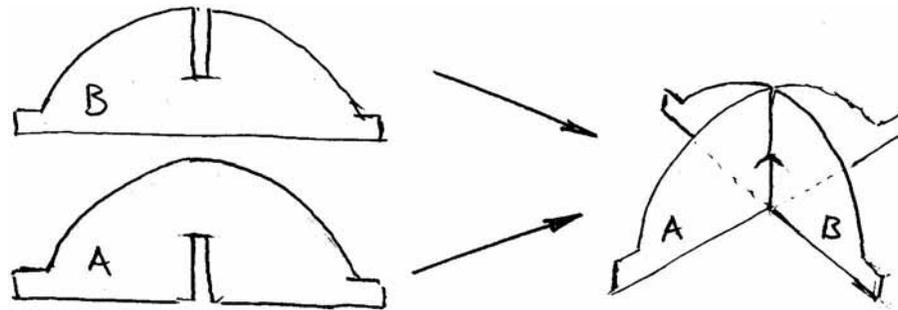


Figure 3: Both parts of the plate-wood model for the cooker assembly

rings in the right position until the whole parabola cage is fixed with wire and welded together and thereby guarantees the right shape of the cage.

2.3 Making the parabola cage

The parabola cage consists of four circles (3 circles \varnothing 8 mm and 1 circle \varnothing 12 mm), six connection bars (\varnothing 12 mm) and 2 pieces of sheet metal $100 \times 100 \times 3$ mm with a 10 mm hole in the center, half of a big nail (\varnothing 5 mm).

2.3.1 Making the circles

The precision of the circles (in combination with using the wood model) is the most important factor for the cooker quality. They have to be made with the highest possible accuracy! It is worth to spend much time on the elaboration of good circles.

Inaccuracy leads to a wider area of light concentration and lower reachable temperatures. As the overall amount of energy collected depends only on the mirror size, this means that the cooking pot is heated up as quick as with a smaller focal area, but at a certain point the heat increase in the pot stops, under very bad conditions even below 100 degree Celsius. While a good parabola shape guarantees for reachable temperatures above 200 degrees Celsius.

So making the circles is possible by bending roughly a circle from a piece of reinforcement bar and the adjusting the final shape by hammering on the circle on a stiff but not rigid underground. The shape has to be controlled by putting the circle on a circle-drawing made on a even surface (wooden plate e.g.). Adjusting has to continue until the circle exactly fits on the drawing with not gaps between the circle and the level ground!

For a production of cookers it is advisable to use a simple circle mashine to bend the circles, or you may want to ask any metal workshops to do the circles for you.

2.3.2 Making the circles with a circle mashine

A circle mashine consists of three cylindrical metal wheels (supported with ball bearings) in a row, where the inner wheel can be adjusted in height above the connection line of the outer wheels to allow the setting different circle diameters. Either the inner wheel or better both outer wheels are connected to a crank or motor to transport the material to be bent (see sketch 4).

Using a circle mashine is the best and quickest way to make the 4 circles needed for the cooker. A helper is needed to hold and guide the ferro and the final circles during the bending process.

The following rules are important to know:

1. The first and the last 10 cm of the reinforcement bar will not be bended nicely. Therefore use a piece of bar which is 20 cm longer than the final length given in the table below and cut 10 cm from each side after bending and before closing the ring by welding.



- Never bend the material too much! Start by carefully trying with a large bending diameter and bend more **in several runs** until the right setting for this diameter is found. **Note the settings of the circle mashine for the next time.**

Feed the bars with a rifeled side up and log paralel ruffles to the sides! Keep the bended ring-material always straight up (vertical).

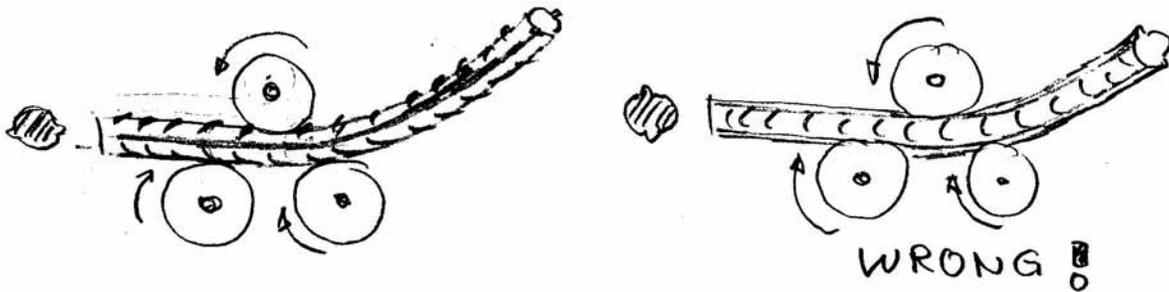


Figure 4: Proper feeding of the reinforcement bars into the circle mashine

- After welding the ring again run the circle through the circle mashine using the same setting as in before (or a little bit stronger bending).

It is best to use about 20 cm longer bar than needed for the perimeter if the ring and to cut both sides with a hack-saw to the right length, because the start and end will not come out good in the bending mashine.

Weld the ring by pressing the gap to close against a block to get the ends parallel. Chip the slack carefully to get a strong connection.

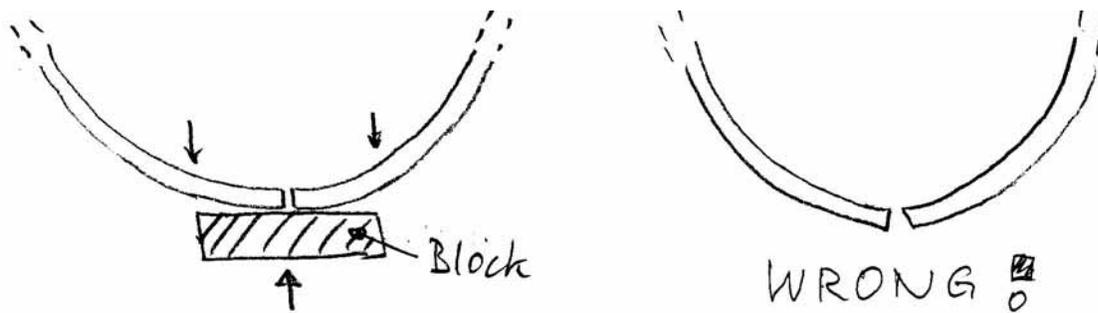


Figure 5: The closure of the rings by welding

- As a last step the circle has to be carefully adjusted to be perfectly plain and round (using the drawing on the working platform).

It helps to run the closed circle again through the circle mashine

Inner circle \varnothing	Material \varnothing	Final length	Part description
140 cm	12 mm	440 cm	parabola cage part I
114 cm	8 mm	361 cm	parabola cage part O
90 cm	8 mm	285 cm	parabola cage part N
52 cm	8 mm	165 cm	parabola cage part M
35 cm	12 mm	110 cm	pot holder ring part T2



2.3.3 Making the cage

1. Cut a piece of bar of the final length plus 20 cm, but mark clearly the final length on the bar (minus 10 cm from each side).
2. Feed the piece into the circle machine and bend it slightly, **don't try to bend it to the final circle in one step!** Repeat the feeding with increased settings for the bending until one end can be fed again before the other end leaves the machine. The circle setting is right if both final end marks are on the same place.
3. After the circle has been bended the 10 cm overhead on both sides has to be cut off with a metal hack saw to the final length, and the ends have to be welded together very well.
4. Feed the welded circle again into the circle machine and make several turns with the last circle setting (or maybe very little stronger setting).
5. Check the circle quality on the working platform and make adjustments if needed. The circle should exactly follow the circle drawn on the platform and there should be no gap between the platform and the circle! (At no place the smallest finger may fit between ring and platform) Turn the ring upside down and check again until everything fits.
6. Mark the positions of the 6 connection bars and the axis of the pot holder permanently on the largest ring.
7. After all circles are checked to be ok, the circles are positioned on the plate-wood-model on the positions of the black triangles.
8. Place the 100×100×3 mm sheet metal (L, see figure 8) with the 10 mm boring in the center on the top center of the model.
9. Cut seven pieces of 90 cm length and \varnothing 12 mm for the ring connection bars (part K). First bend only one bar according to figure 7. Then try it out at the wood-model with the rings. The connection bar has to touch all the 4 circles and the sheet metal without any force and without moving the rings! Normally several little corrections of the bending angles are needed until it fits.

If the connection bar fits mark it with color as your model piece and keep it together with the wood-model for the next cooker production.

Now make six connection bars using the model to adjust the right bending angles.

10. Take one connection bar after the other, make corrections until the bar fits nicely (see figure 7), put it in one position marked on the largest ring and fix the connection bar with iron wire and pincers. Be very carefully not to move the ring during the twisting of the wire!
11. Make a last quality check that the rings are still in the arrow positions and the connection bars are fixed in the right position.
12. Then **punctual** weld the connection between connection bar and the sheet-metal. Be carefully only to weld short time and may be to put an other sheet metal piece under it, not to burn the model.
13. The wood-model now can be carefully removed and the wire connections can be replaced by welding. First weld all connections punctual and then finally.
14. All except of one piece of the connection bars which are longer than up to the largest ring have to be burned off by heavy welding. On the remaining end a sheet metal 100×100×3 mm for the solar indicator has to be welded to be about parallel to the largest ring. Weld the piece of the thick nail or a ferro \varnothing 4 mm vertical in the center of the sheet metal.

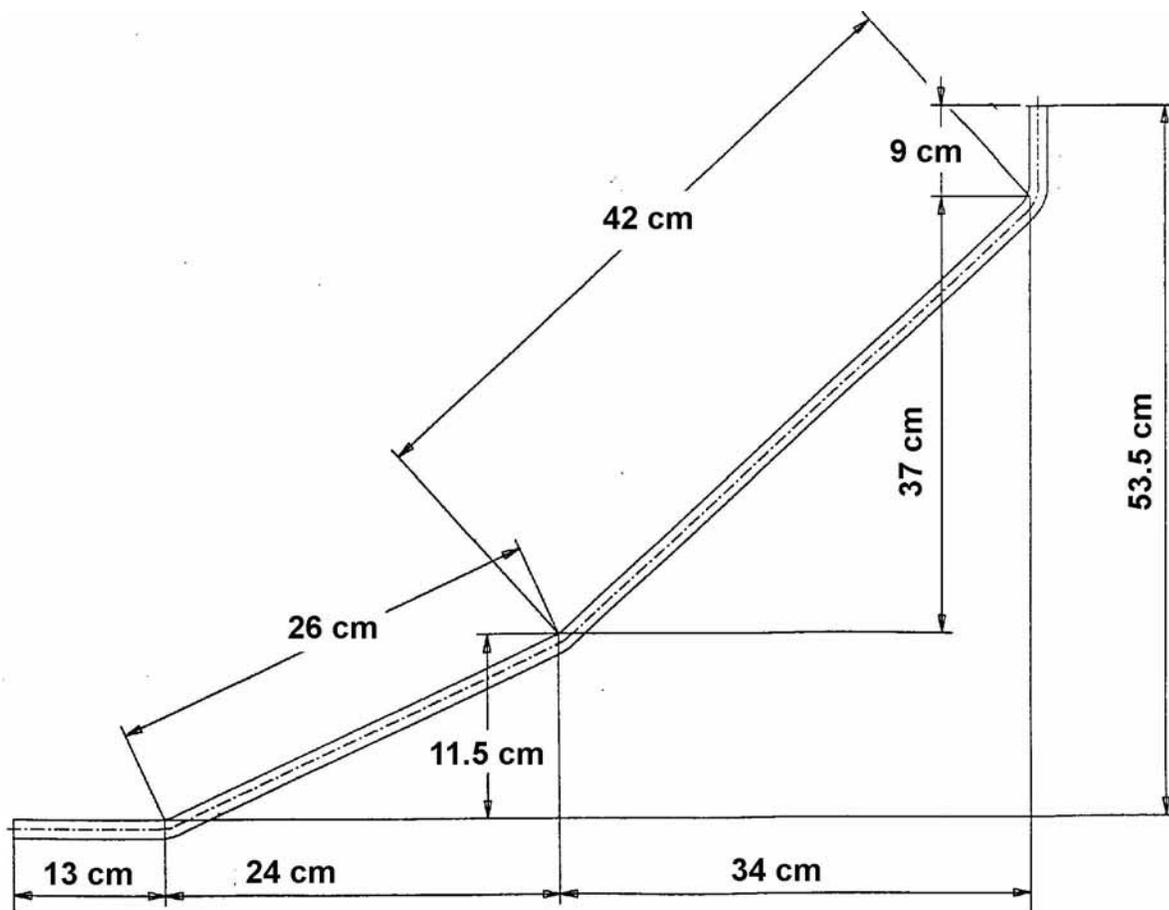


Figure 6: The measurements of the connection bar K

2.4 Making the pot holder part

The pot holder part consists of the main bearing bar (\varnothing 12 mm), 2 sheet metals $150 \times 100 \times 3$ mm, the central circle (\varnothing 12 mm) and the pot grid (\varnothing 8 mm).

1. Cut a \varnothing 12 mm bar of 1.80 m length. Mark the center and the points in 17.5 cm and 75 cm from the center.
2. Add the 2 sheet-metal pieces (F, see figure 8) $150 \times 100 \times 3$ mm to the bar on both ends by pushing the bar through the 14 mm holes.
3. Bend both ends outside of the 75 cm mark into the same direction by 90 degrees so that the sheet metals are within the bends. This is the main bar.
4. Put the main bar on the floor so that the ends are pointing vertical up. Place the \varnothing 12 mm pot-holder ring horizontal and central (using the 17 cm marks) on the bar and weld the contact points **very strong**. The sheet metals have to be outside of the ring, one on each side. (see figure 9)
5. Burn out the piece of the main bar which is inside the pot holder ring and check if the ring and the main bar is welded together **very strong**.
6. After finishing the whole cooker check with a white paper, — while the cooker is adjusted nicely to the sun, — in which depth below the ring the focus of the mirror is (where the white paper shines the brightest, wear sun-glasses for thid test!!)

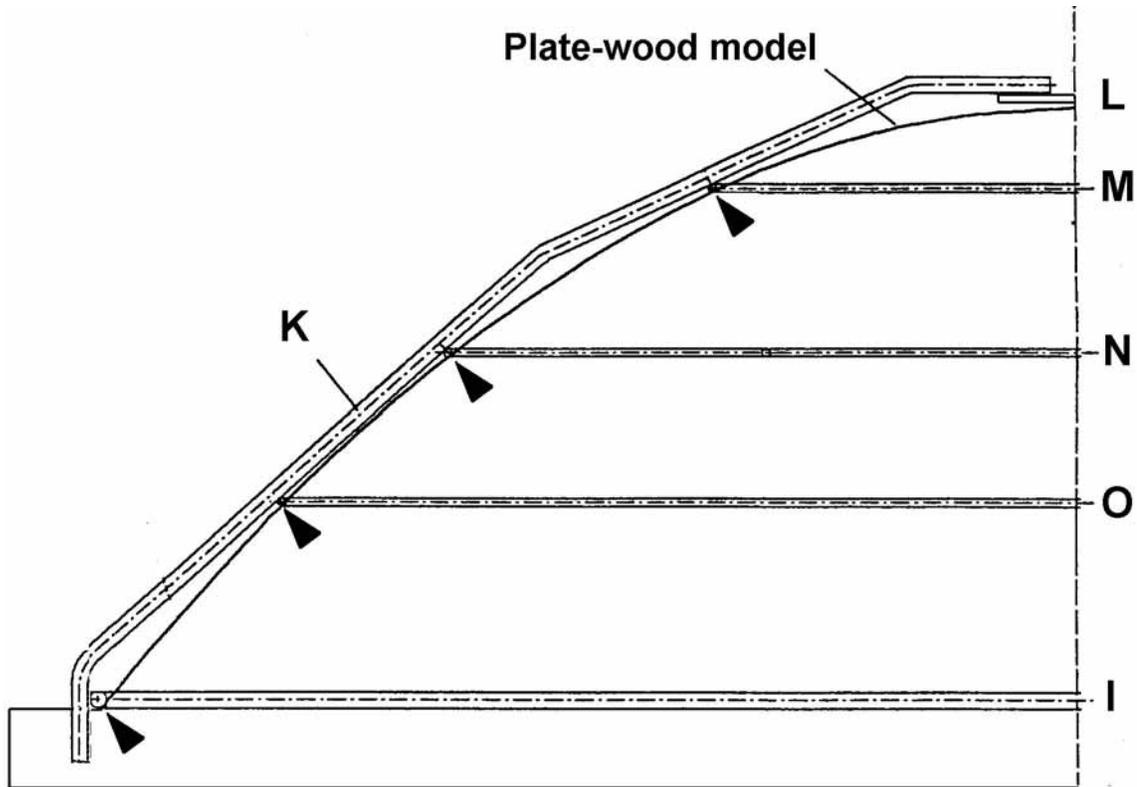


Figure 7: Connection bar K perfectly attached to the circles on the wood model

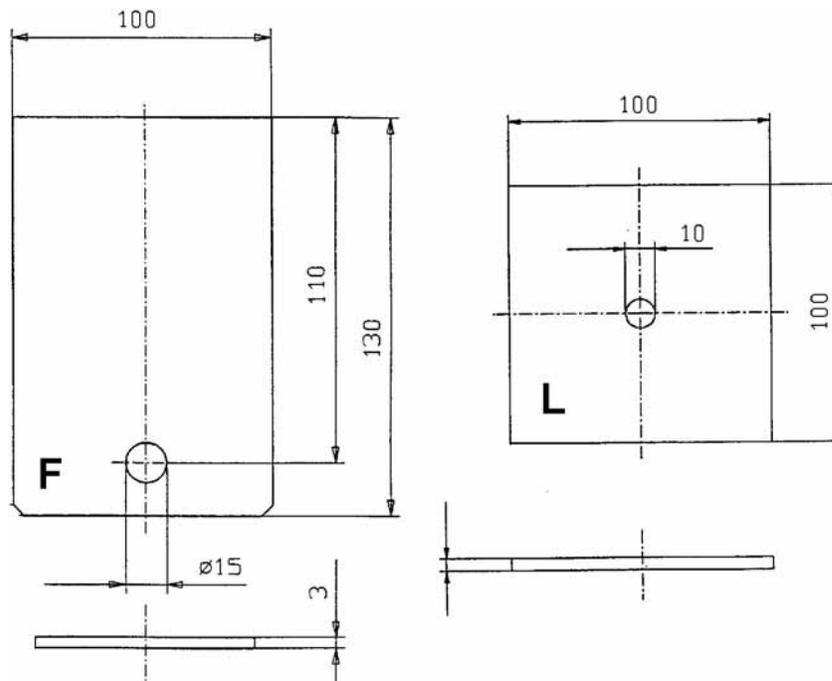


Figure 8: The sheet metal parts F and L

Then make the pot grid out of \varnothing 8 mm bars. Make a \varnothing 12 cm circle and weld two 35 cm long pieces parallel and central to both sides. Place this ring central to the pot holder circle. Marke where to bend up the ends that the ring can be placed in the focus depth below the



ring. Finally bend back the ends according to the right depth to get a pot holder for the Ethiopian coffee pot as shown below.

In a similar way pot-holders for different pot sizes can be constructed according to the wishes of the user.

2.5 Making solar cooker foot

The solar cooker foot consist of 2 triangular sides, 2 straight connections of 1.5 m length, 2 handles (all pieces \varnothing 12 mm), the 2 pipe pieces and two chord clamps (\varnothing 8 mm).

1. Cut 2 straight pieces of \varnothing 12 mm material 1.5 m long. These are the parts A1 (see figure 11).
2. Cut 2 straight pieces for A2 of \varnothing 12 mm material 2.61 m long. Mark the center of the length and mark to both sides of the center the distances 37 cm and 112 cm (about 18 cm should be the remaining length to the end of the bar piece).

Bend first at the 37 cm points to get a triangle where the ends are crossing each other at the 111 cm points. then bend the short ends after the 111 cm point to be parallel and vertical to the base side of the triangle (see figure 11)

After making the two triangles check if they are of equal shape by putting them next to each other. Turn one triangle by 180 degrees and check again. If the triangle agree in both ways the short upper end is vertical.

3. Weld the two 16 cm ends of the triangles (A2) together and weld one piece (A4) of 1/2 inch pipes parallel to the ends on one side of each triangular foot, so that the upper ends of pipe and foot agree.
4. Cut 2 straight pieces for A3 of \varnothing 12 mm material 1.7 m long. Mark the two points 74 cm from the ends of the pieces and bend there both ends about 50 degree into the same direction so that the end points are 77 cm apart from each other (see figure 11).

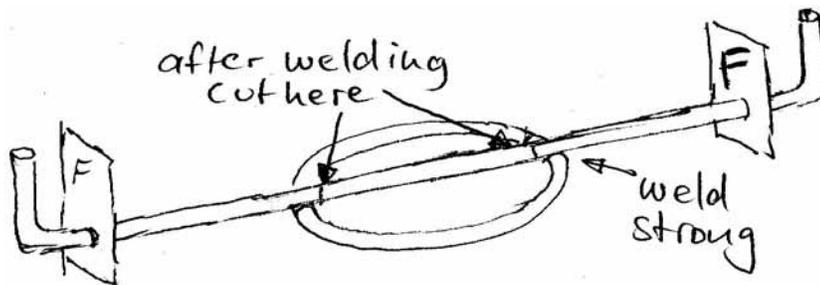


Figure 9: The pot holder part

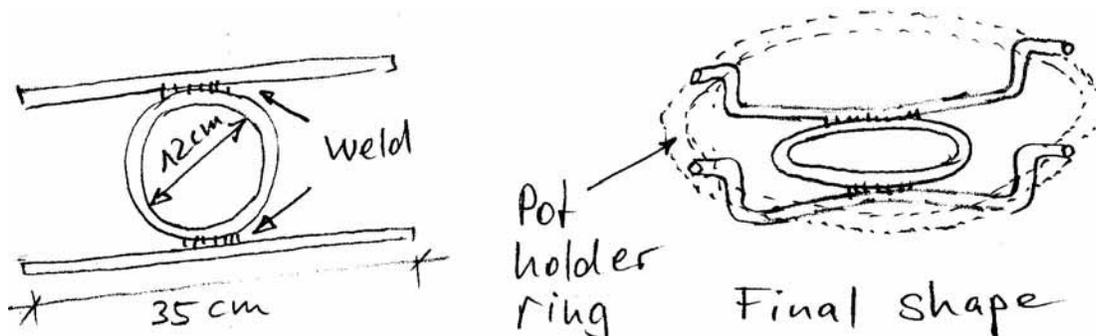


Figure 10: The pot holder grid for small pot and the Ethiopian Jabena

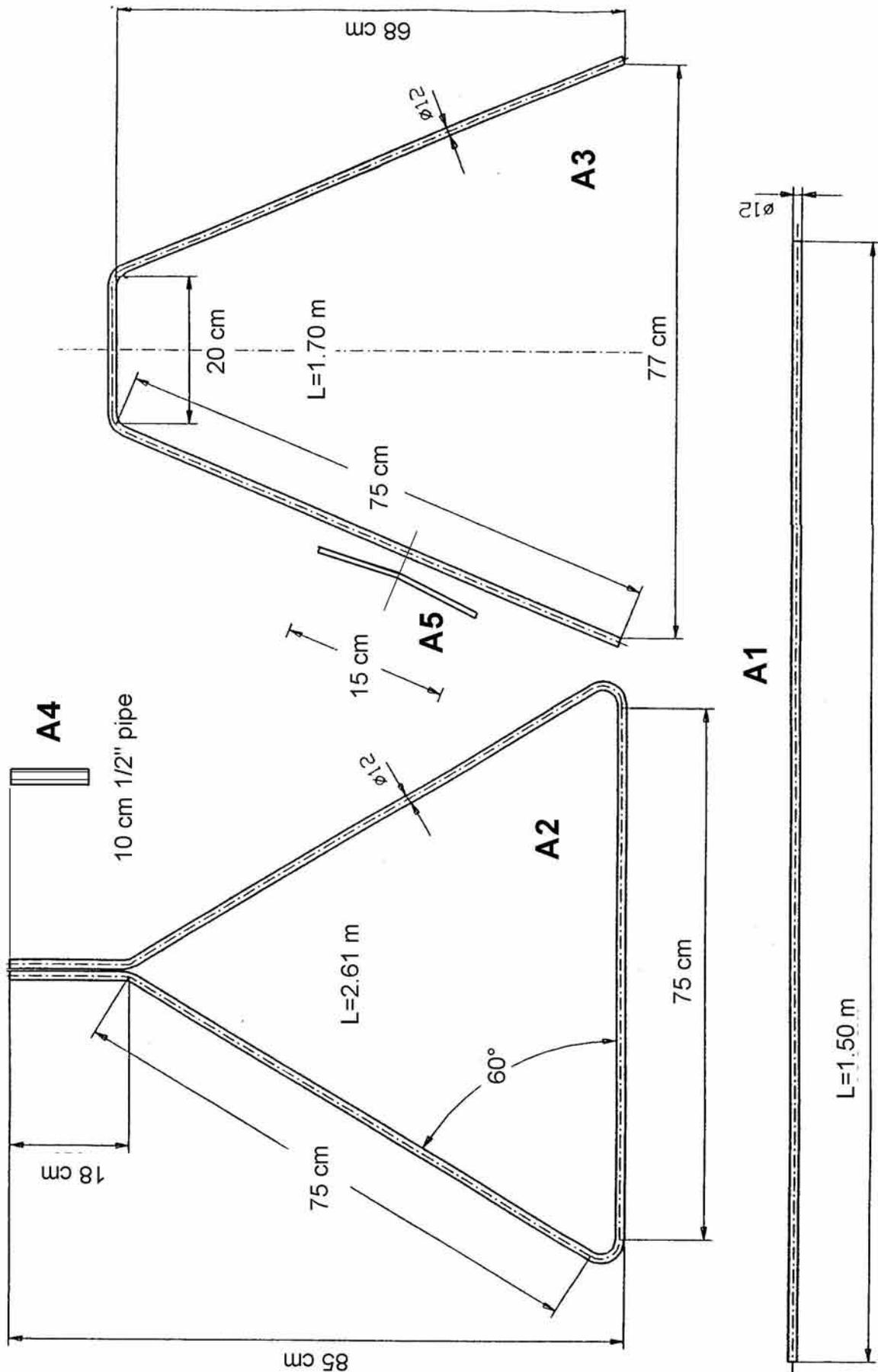


Figure 11: Parts A1, A2, A3, A4 and A5 needed for the cooker foot



5. place the two triangles (A2) on the working platform on the square lines with the pipes (A4) to the outer sides and set the pot holder into the pipes. Connect the two straight parts (A1) with wire at the inner side of the triangle bend. Adjust the foot so that both triangles and one straight bar cover three lines of the square on the platform.
6. Attach the handle bars (A3) on both sides in the triangle so that the connection between the handle and the straight bar (A1) has a distance of 40 cm from the triangles (A2) and the triangles are vertical, and fix all connections with wire.
7. Move the foot from the platform and weld every connection first punctual and then finally, **but don't weld the pot holder bar to the pipes!**
8. Finally add a chord clamp (A5) piece \varnothing 8 mm and 15 cm long to the lower third of the handle bars on diagonal opposite sides.

2.6 Finalising the metal work

To finalize the metal work, the parabola cage has to be welded to the pot holder part, and the solar clock has to be fixed. With a water level it has to be checked, that the ring of the pot-holder is horizontal.

1. Check where the marks for the axis are on the largest ring of the cooker and push at this positions the pot holder bar through the cage, between the largest and the next smaller ring.
2. Lift the pot holder together with the parabolic cage and install the pot holder bar in the pipes of the foot.
3. Adjust the sheet metal pieces vertical up with the hole at the bottom and lift the parabolic cage with the largest ring on the edge of the sheet metal, so that the center of the sheet metal agrees with the marks on the ring for the axis. weld the ring to the sheet metal in this position.

The pot holder bar should now be close to the second ring, the sheet metals should be vertical and the parabolic cage in equilibrium should be horizontal.

4. Adjust the parabolic cage so that the sheet metals have the same distance from the pipes. Weld 2 short \varnothing 8 mm pieces on the pot holder bar so that they just touch the sheet metal on the side of the pot circle. **Don't weld anything to the sheet metal!**

2.7 Painting

Often the cooker might be exposed to rain and the metal will corrode if not protected. To get a good corrosion protection and a nice outlook the following steps are recommended.

1. Clean all dirt and loose corrosion particles from the metal by a wire brush.
2. Paint all parts at least once with anti-rust paint! Don't use old and already thick paint for the first cover. The paint has to be thin-liquid and special care has to be taken that the paint reaches all little holes and gaps especially at the points of welding. Be sure that everything is covered and that the paint is completely dry before painting again.
3. To improve the outlook of the cooker make a final cover with white paint. Don't use a dark color as then the metal heats up too much in the sun.

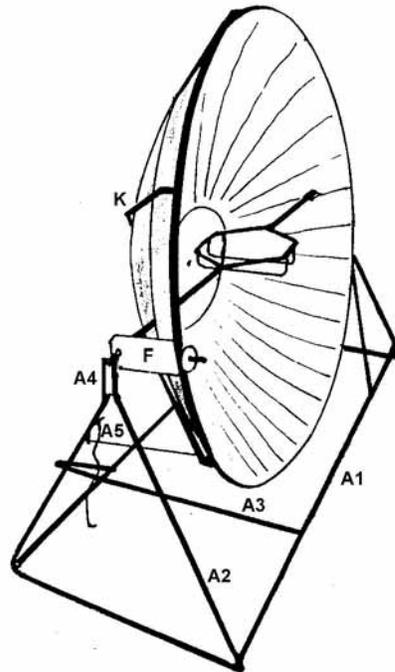


Figure 12: Finalized cooker showing the assembly of the foot parts

2.8 Mounting the aluminium panels

If the parabolic cage has the right shape, then the installation of the mirror panels is easy. The more the shape is different from the right form the installation becomes a hazzel! At the position of each of the rings the panels have two little holes to be placed on each side of the ring and the holes of neighboring panels should come to the same position. For fixation the wire is meant to pass through the lower holes of the neighboring panels, around the cage ring and then trough the upper holes of the neighbouring panels.

Using the \varnothing 1.5 mm aluminium wire seems the best way for fixing the panels if the shape of the cage is good. In difficult situations using the telephone wire might be more versatile.

The mirror side of the panels is protected by a thin plastic cover which has to be removed **before** installing the panels.

1. There are 4 of the 36 long aluminium panels where an edge of the long side is cut out. This panels have to be fixed first on both sides of the parabolic cage, so that the pot holder bar passes through the mirror in the center of the cut out part. Fix these panels at the smallest and at the second largest ring.
2. Now fix all other 32 long panels on the smallest ring in a lose way, always joining 4 holes with one wire. For the last panel to fit it may be neede to pull the other panels as far apart from each other as possible.
3. Next connect all penal loosely with the second largest ring. Again pull the panels as far apart from each other as possible.
4. Now the connections with the outer and middle ring can be done as well, and the connections to all but the smallest ring can be already fixed finally.
5. Finally the 12 inner triangular panel can be fixed. Pull off all protection foil and put the screw with the washer from the shining side trough all panels. Loosely add a nut to hold the hole pile together, put the screww into the central hole in the cage and loosely fix the screw with an other nut.

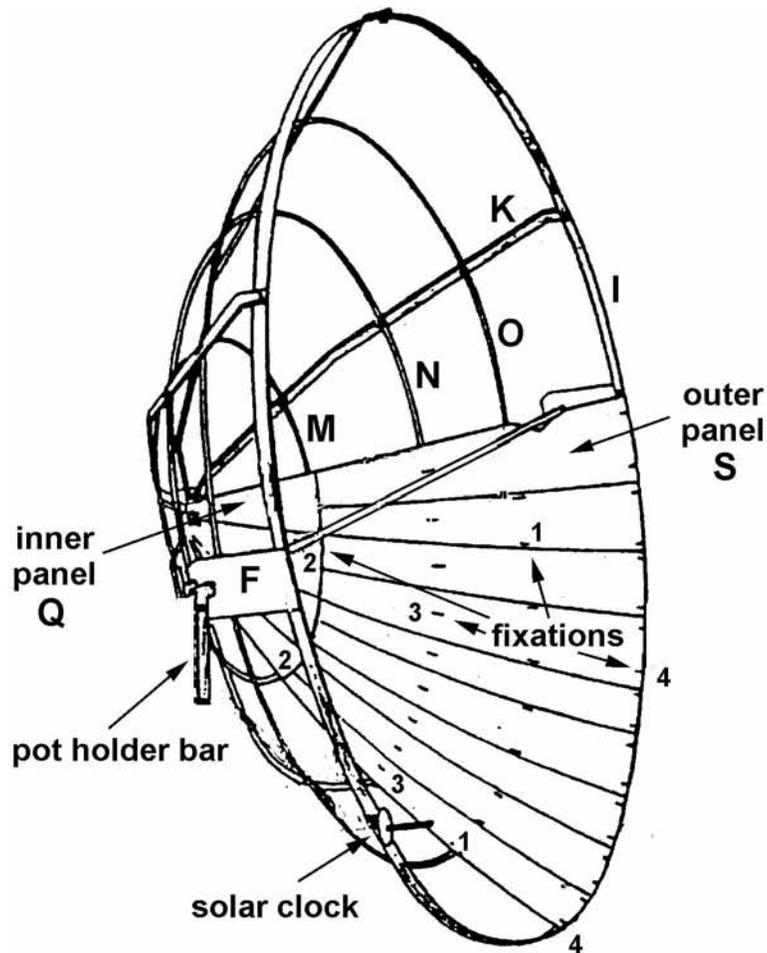


Figure 13: The fixation points of the aluminium panels

The panels now can be spread to just cover each other. The outer holes should agree with holes of the long outer panels. To fix the panels remove the wire from the long panels and fix all three panel with the same wire. Or add a new wire to fix the inner panel, but it might be sometimes difficult to place two wires through the holes.

6. Fix the nut of the central screw and add an other nut to ceep the screww from getting loose.
7. Fix all wires on the back of the mirror nicely cutting ends which are longer than needed.

CONGRATULATIONS!

2.9 How to make the mirror panels?

For the beginning it is advisable to buy a prefabricated set of mirror panels which can be ordered from *EG-SOLAR e.V., Neuöttinger Str. 64c, 84503 Altötting, Germany.* or from the EG-SOLAR home page:

<http://home.t-online.de/home/eg-solar/eg-sol~1.htm>

If you really want to make the panels yourself as well the design od the inner and outer aluminium panels are given on the pages 16 and 17.

2.10 Testing and adjusting the cooker

Testing and adjusting is only possible in bright sunshine with clearly visible shadows.

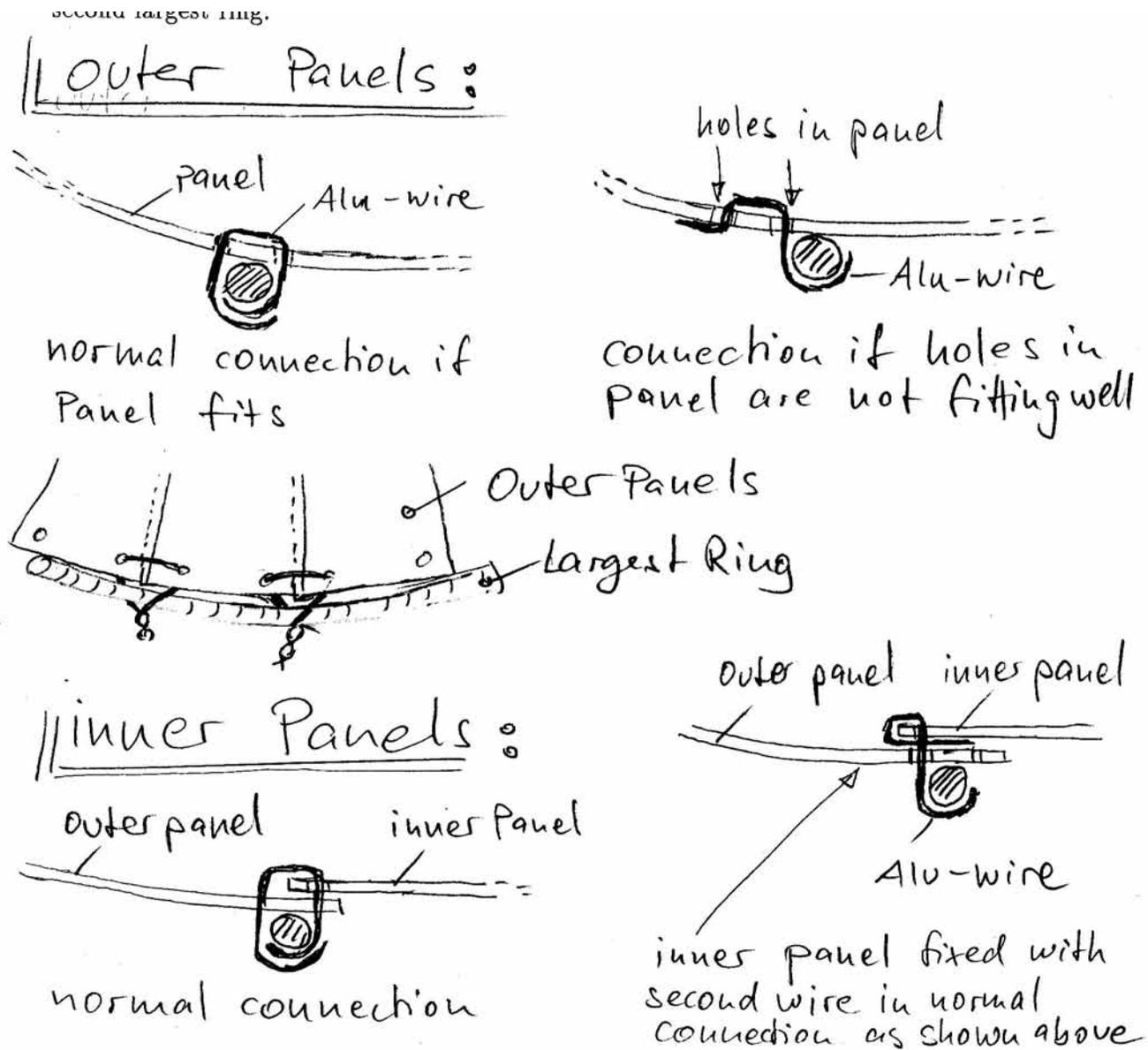


Figure 9: Some tricks, which to fix the panels with the wire if the holes in the panels do not fit perfectly

Figure 14: Some tricks, how to fix the panels with the wire, if the holes in the panels do not perfectly fit

The solar clock has to be adjusted to indicate the best focusation of the light into the cooking area. It should be possible to inflame a white paper or at least a newspaper. One liter of water in a black metal pot should boil in 8 to 10 minutes.

1. Adjust the opening of the chord clamps to ceep the chor in position when wrapped around.
2. Adjust the cooker foot on the floor in the sun direction. Turn the foot on the ground until the vertical part of the triangular side makes shadow on the horizontal side of the triangle on the ground.
3. Attention: For this step sun-glasses are recommended. Put a white sheet of paper on the cooking area and adjust the inclination of the mirror to get the brightest and smallest possible

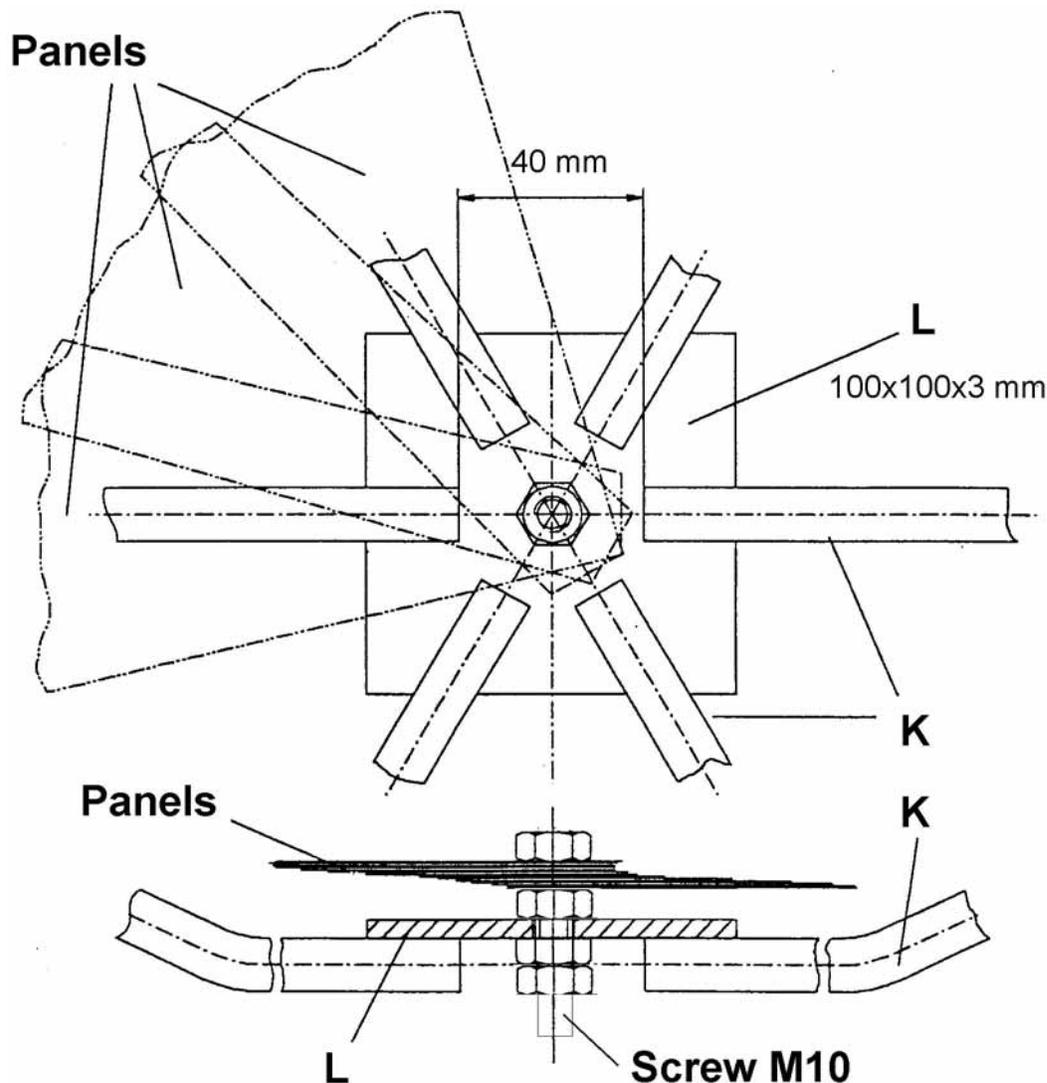


Figure 15: Fixation of the inner panels with an M10 screw

light-spot on the paper. Fix this position with the cord. Now bend the nail of the solar clock so that the shadow of the nail becomes a single small spot.

4. Check several times if the solar clock now gives the position of the cooker where the light spot in the cooking area becomes the brightest.

3 Usage instructions

- Use **black** pots preferable with a lid. Clay pottery is ok too, but cooking then takes a bit longer time.
- Keep the mirror clean and avoid scratching the mirror surface.
- **Use only liquid cleaning aids and only use a clean cloth without sand or mud sicked to it.**
- When the cooker is not used, tur the mirror completely upside down so that the reflecting side points to the ground and does not catch rain and dust.

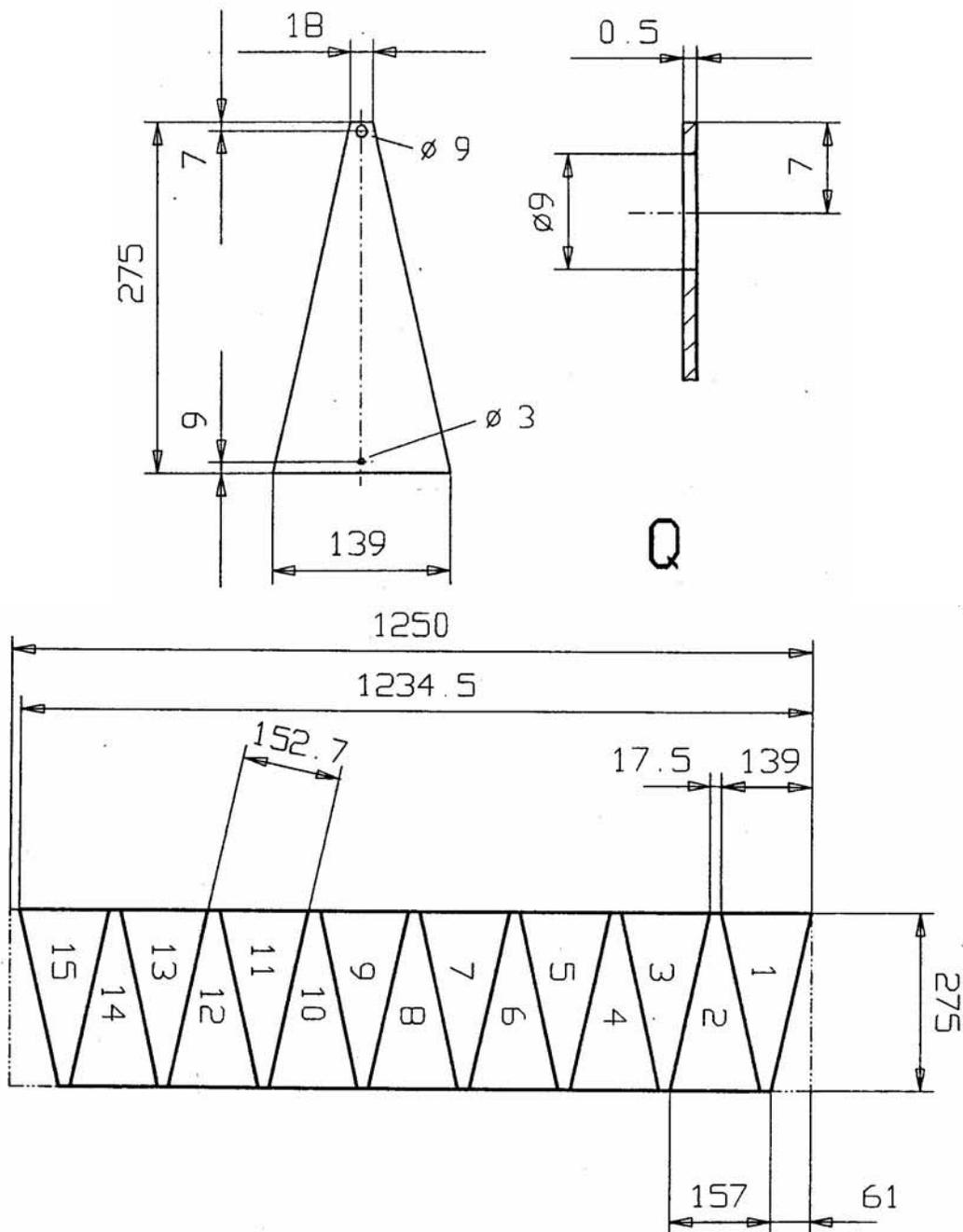


Figure 17: The 12 short mirror panels Q



- While cooking avoid shadow on the mirror, step aside when stirring in the pot for a long time.
- Regulate the cooking temperature (switch the cooker on and off) by adjusting and deadjusting the mirror to the sunlight, using the integrated solar clock.
- For full cooking power re-adjust the mirror to the moving sun about every 10 minutes, using the integrated solar clock.
- Wear sun-goggles (sun-glasses) if you need to look into bright reflexions **for a long time** or if it is more convenient for you. The light reflexions coming from the mirror are not brighter than the light coming from the sun (unless you are putting your head right into the focus in the cooking area) and our eyes are able to look into the sun for a short time without damage, but putting something bright white (like a sheet of paper) into the focal point and looking at it for a long time may lead to problems.
- Make a shade next to the cooker for convenience, so you can stay in the shadow while the cooker gets full sunlight, ore use an umbrella.
- For cooking operation it is best to place the cooker on level and horizontal ground with not easy inflammable material like dry gras, paper or kerosine in the next surrounding.
- Re-adjust the cooker every 10 to 15 minutes to get optimal results. Cooking stops automatically after some time if the cooker is not re-adjusted to the sun.
- During operations at the cooking pot like sirring, adding food ore moving the pot, the mirror can be de-adjusted (vertical) to avoid looking into reflexions and to polute the mirror surface by dropping food.
- Don't move the whole cooker with a full pot on it.
- If possible use a lid on the cooking pot, which gives more heat in the pot.
- In windy regions use a wind protection, as wind is cooling the cooking pot, reducing the available heat.
- Small pots are more effective, because large pots (or Injerra-Plates) are making by them selves too much shadow on the mirror.
- For baking use two pots, one inside the other with an air gap all around the inner pot or baking tin.



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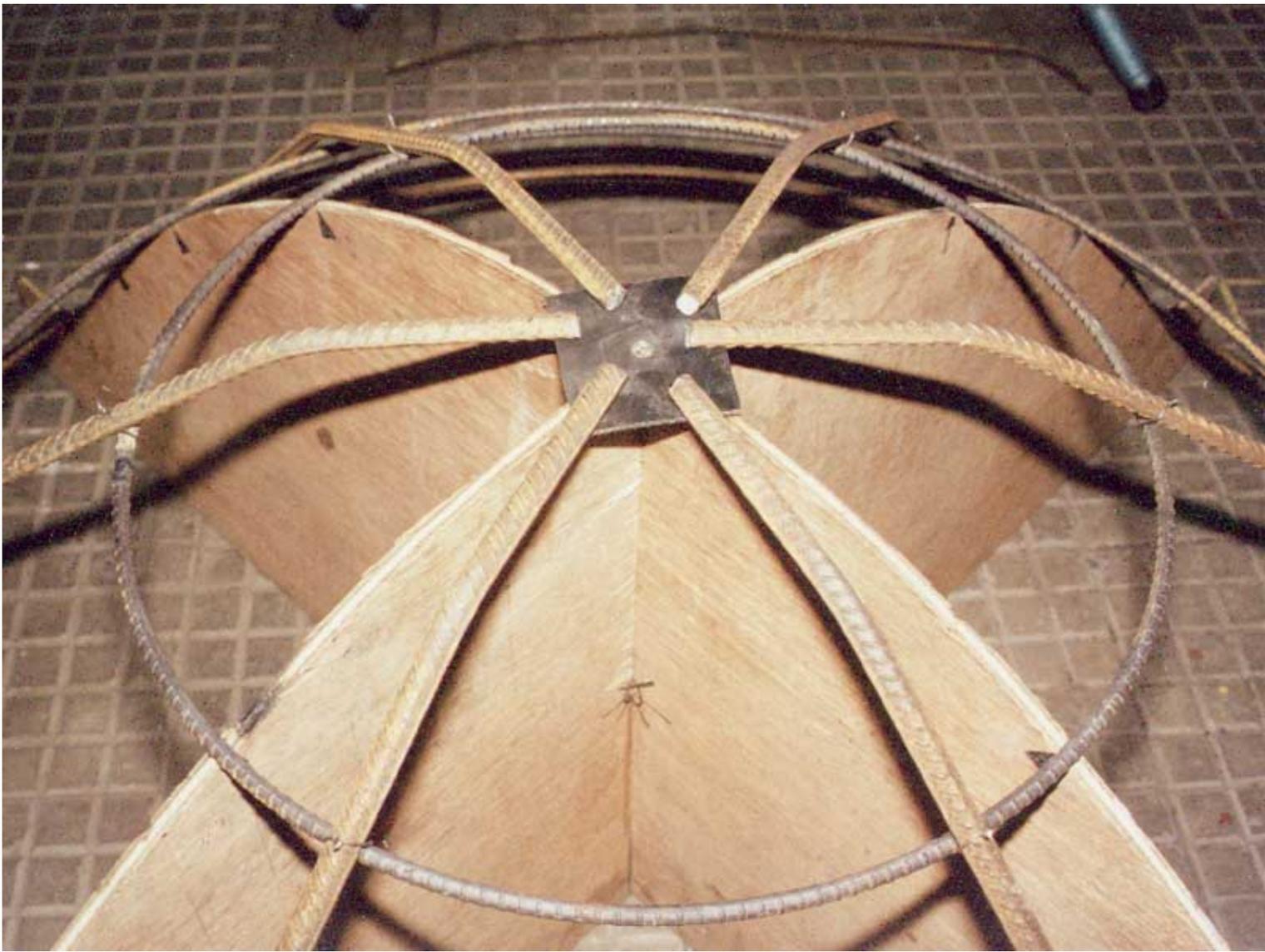






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This page provides some information about experiences on promoting the use of a simple parabolic solar cooker to save firewood in Ethiopia. During my two year stay in the town Arba Minch I tried hard to found a solar cooker workshop for a small local production of solar cookers and to teach women in the usage of these cooker type for the preparation of traditional food.

Anybody who is interested in the **Construction and Use of Parabolic Solar Cookers** is invited to share my experiences and get:

- [Home](#)
- [General information's about the critical situation in Ethiopia](#)
- [The good Idea of Solar Cooking](#)
- [Information's about the AMSI project](#)
- [A description of the AMSI solar cooker](#)
- [Technical Data of the AMSI / EG-SOLAR solar cooker](#)
- [A booklet of LECTURE NOTES containing all these topics](#) (pdf, 1MB)
- [Detailed CONSTRUCTION PLANS and instructions to build the AMSI cooker](#) (pdf, 3MB)
- [Operation instructions and safety rules](#)
- [Cooking rules and procedures](#)
- [Information about EG-SOLAR, the parents of AMSI](#)
- [Pictures of the Project Implementation](#)
- [Other Solar Cooking projects in Ethiopia](#)
- [Interesting links to further information's on solar cooking](#)
- [9. International Conference on Solar Cooking in Germany \(Burghausen, 24./25.03.2001\)](#)
- [Parabola Design and making the Wood-Model](#)

The AMSI solar cooker project is based completely on my private initiative and money and not linked to any governmental or non governmental organization or support.

For discussion and support e-mail to the amsi-solar@gmx.net

This site was last updated on March 27, 2001.

[Counter](#)



The Idea of

Solar Cooking

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.

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 aluminum 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 SK-14-cooker developed by the German [EG-SOLAR e.V.](#) 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 *Whot's* can be prepared on it in the usual way. Even making (small diameter) *Injera* is possible and it takes only 8 minutes for one liter of water to boil!

For only about 600.- Birr (80 US \$) it will save a lot of money and firewood for the next ten or twenty Years!



[Click on picture to enlarge it](#)

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.

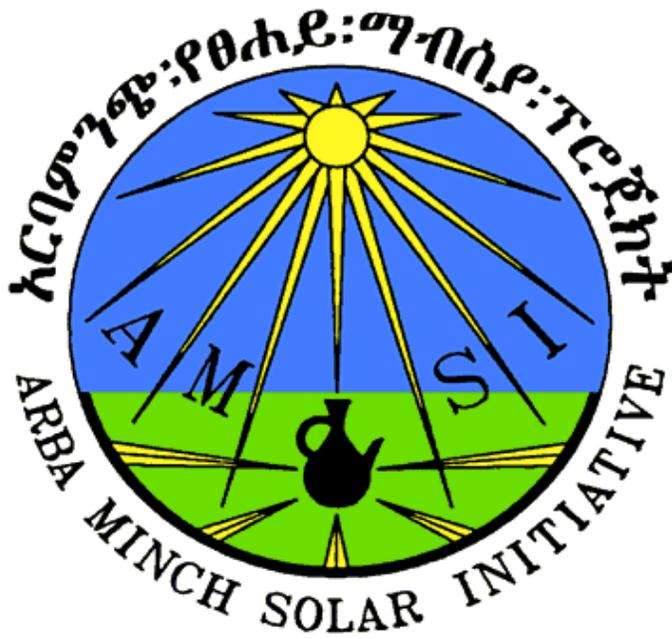
Everybody who no longer has to buy fire wood will at least save a lot of time, his health and the beautiful nature of Ethiopia.

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 sterilize more than 50 liters of drinking water per day without extra cost or impact on nature!

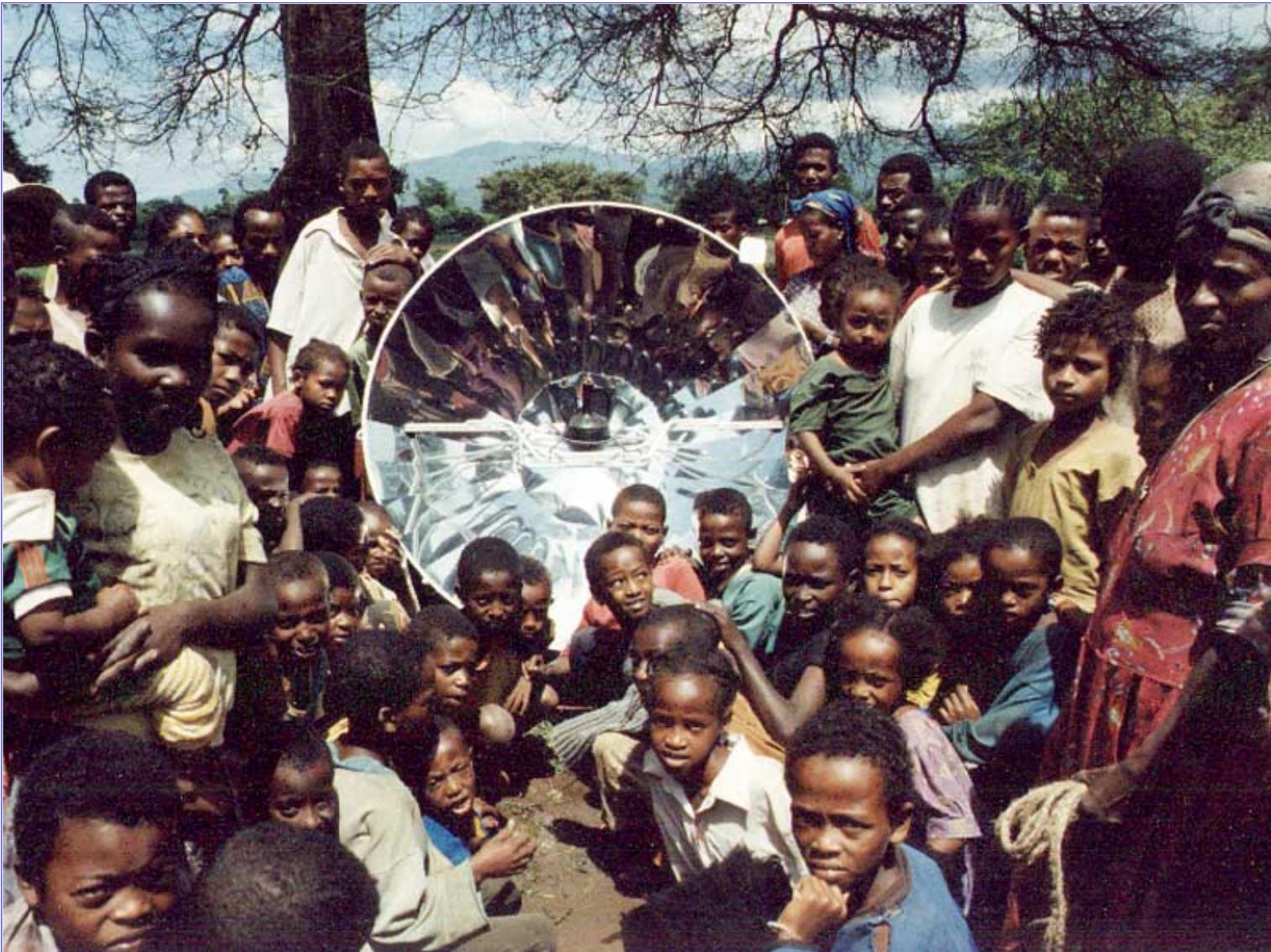
The cooker is also ideal to distill alcohol from organic matter. This means it can not only be used to produce *caticalla* but also to distill fuel to be used for light and kerosene stoves.

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[A Solar Cooker Project in Ethiopia](#)







The Situation in Ethiopia

Ethiopia is a blessed country

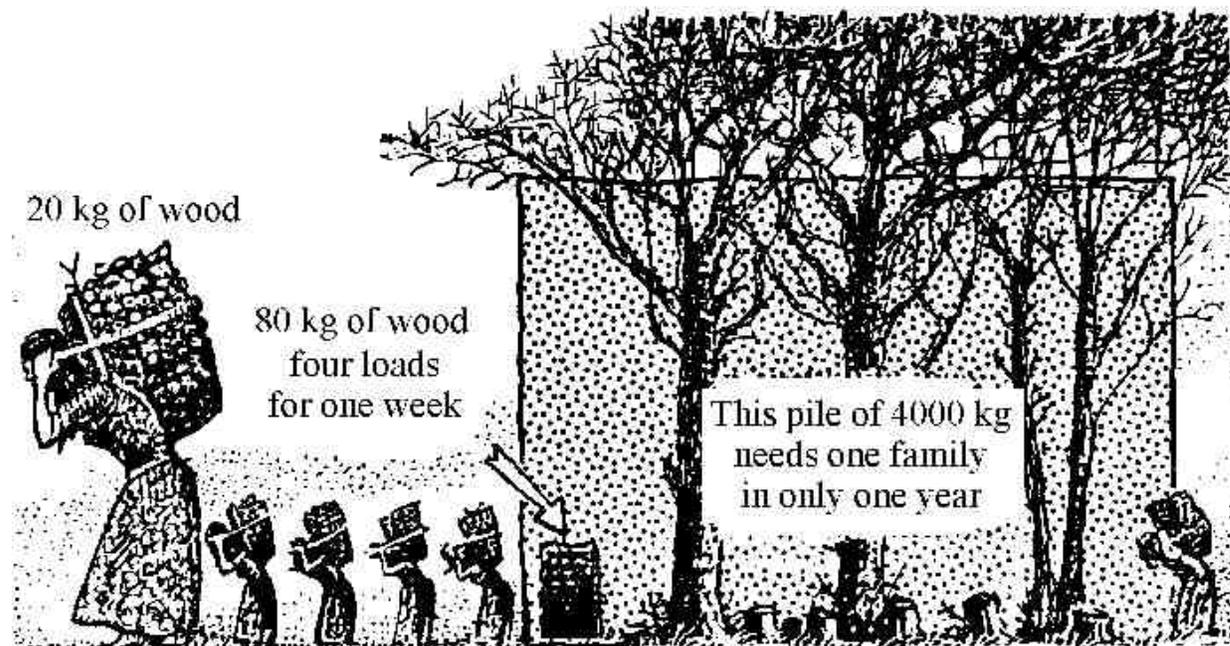
Ethiopia is a country which is blessed with sunshine! The light energy coming from the sun to Ethiopia is so abundant, that the energy would be large enough to supply the whole world with electric power! *Thirteen months of sunshine* is the slogan of the Ethiopian Tourist Organization and it seems that 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 recognize 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.

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 industrialized 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 ([see picture](#)).



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 deforestation is even 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!

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 ([see picture](#)) 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 in the trees around Arba Minch! It is easy to see zebras, crocodiles, kudus, hippos, hyenas, porcupines, mongoose, Civet- and Genet-cats, warthogs, different snakes, turtles, bush bucks, 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 ([see picture](#)) 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.

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Information's

about AMSI

What does AMSI mean?

AMSI is the shortcut for *Arba Minch Solar Initiative*. The aim of AMSI is to stop the deforestation in Arba Minch and the surrounding by spreading the good 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.

All members of AMSI are working on a *non-profit* basis and everybody who wants to support the idea of AMSI is invited to participate with ideas, teaching and other supporting activities.

AMSI was founded and promoted by Mr. Ernest Willand (the author of these pages) and Ato Muise Gipo with the support of the Arba Minch Water Technology Institute ([AWTI](#)) during the year 1997. The responsibility for the project then was handed over to the *Appropriate Technology Center of the AWTI* and the *Women Project of the Kale Heywet Church in Arba Minch*.

You can may get information on the current status of the project from:

AWTI- Appropriate Technology Center ([homepage](#))

c/o Ato Hailemariam Desalegne

PO Box 21

Arba Minch

Ethiopia

awti@telecom.net.et

GTZ Project Administration ([homepage](#))

Household Energy Project

c/o Mrs. Trudy Könemund

PO Box 12631

Addis Abeba

Ethiopia

Fax: 00251-1-653819

gtz-biomass@telecom.net.et

University of Stuttgart [\(homepage\)](#)

Otto-Graf Institute (FMPA) [\(homepage\)](#)

Section 44

c/o Dipl.-Ing. Ernest Willand [\(homepage\)](#)

Pfaffenwaldring 4f

70569 Stuttgart

Germany

Fax: 0049-711-685 6826

amsi-solar@gmx.net

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The AMSI

Solar Cooker

Development of the AMSI Solar Cooker

The cooker used and promoted by the AMSI is based on the solar cooker [EG SOLAR SK14](#) developed by the *Foreign Aid Group Solar Cooker of the State Technical College Altoetting e.V.* in Germany. This Non-profit organization 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 was brought by the AWTI lecturer Mr. Ernest 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 half a year of practical co-operation between Mr. Muise and Mr. Willand a technique had 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 plate wood to guarantee a high accuracy and quality of the cookers and using only few standard tools available in any metal workshop in Arba Minch. With the plate-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 (340 US\$). The total material cost used for one AMSI cooker is less than 150.- Birr (25 US\$) for local material and about 300.- Birr (50 US\$) for the mirror material (aluminum sheets).

The aluminum mirror material for the AMSI cooker up to now has to be imported from Germany, as aluminum is not produced in Ethiopia. The mirror material for one solar cooker has a package size of 5 X 15 X 50 cm and a weight of 3 kg. The panels needed for one cooker are precisely prefabricated and can be applied without any extra work.

Why a Parabolic Mirror Solar Cooker?

Compared to Box-Type solar cookers Parabolic Cookers are more expensive and more difficult to build. But they have the big advantage to reach a cooking temperature in the focal area which allows to cook nearly in the same way as on open fire. The traditional Ethiopian dishes (Injera and Wot) are not possible without frying onions, spices and meat which is possible only at high temperatures. Preparing fresh roasted coffee is part of a good meal. So the parabolic cooker which comes close to the use of open fire is most appropriate to the cooking traditions. In Arba Minch there are only in the short rainy season some clouds sky, so there is no need to use diffuse light as well. The high efficiency of the parabolic cooker under these conditions makes it even possible to share one cooker between several families.

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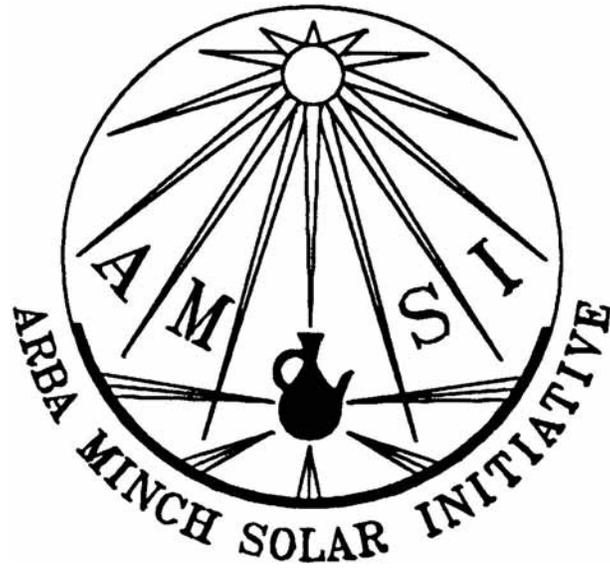
Technical Data

Technical Data

Usable Energy:	About 600 to 800 Watts
Maximum Temperature:	About 198 degrees Celsius
Time needed to boil water:	1 liter water boils in about 8 to 10 minutes About 50 liters water can be boiled per day
Overall cooker size:	80 cm / 160 cm / 160 cm
Size of the parabolic mirror:	Diameter 1.4 m, area 1.54 m ²
Weight:	About 34 kg

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Lecture Notes on Solar Cooking





1 General Information

1.1 Ethiopia is a blessed country

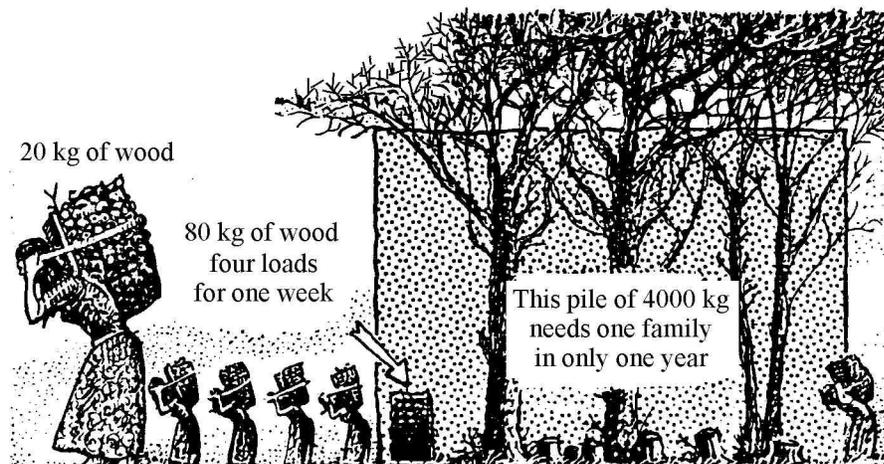
Ethiopia is a country which is blessed with sunshine! The light energy coming from the sun to Ethiopia is so abundant, that the energy would be large enough to supply the whole world with electric power! *Thirteen months of sunshine* is the slogan of the Ethiopian Tourist Organisation and it seems that 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, warhogs, 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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Safety

Rules

A parabolic solar cooker is nothing dangerous, at least to my opinion it is far less dangerous than the use of open fire used for cooking by burning wood, kerosene or gas.

Most people are afraid of the reflections of the sunlight in the mirror hitting the eyes accidentally while handling with the solar cooker. In fact it is not nice if sunlight suddenly hits your eyes, but it is not more dangerous than the sunlight flickering through the leaves of a tree when we look up into the sky. The eyes are capable to be exposed to the full sunlight for a short moment without being damaged, otherwise most people on the world should be already blind! ([click here for more](#)). And:

The light reflected by the cooker is not more dangerous than the direct sunlight

as long as your head is not inside the mirror of the AMSI-cooker! **WHY?** Because the rays of sunlight are concentrated to the focus and the closer they come to the focal area the higher is the light and energy concentration, but if they don't hit the cooking pot or anything else in the focal area, then the light beams continue their straight way and will be diffused again. So the light intensity increases on the way from the parabolic mirror surface to the focal area and it decreases again after passing the focal area. This makes parabolic solar cookers with a focal area outside of the mirror much more dangerous than the AMSI-cooker, because people and burn able things are more probable to come into the area of light and heat concentration. After a travel from the mirror to the focus and the same distance again the light concentration is the same as direct sunlight and after a longer distance it is even less than that. That means that the light intensity of reflections from the AMSI-cooker is less than direct sunlight and will not lead to any permanent eye damage. But anyway:

Don't put your head inside the cooker (close to the focal area)

But usually nobody does, because it is very hot there as well, and you would not put your head into open fire, won't you? Maybe small children may come close to the focal area with their head, when cooking in the morning or evening hours when the mirror has to be set nearly vertical to catch the light. Small children like and tend as well to stare into strong light and they might have a long reaction time to something that hurts. Therefore:

Keep small children attended and in distance from the cooker

But the distance of your arm length is enough, so no problem cooking with a baby on the back. So

the light coming from the cooker is not more dangerous than sunlight. But staring into bright light for a long time might of cause damage your eyes! This happens for example often when people are watching an eclipse of the sun without proper eye protection. The light coming from the mostly covered sun is much less than the full sunlight, but it can already cause injuries, when people stare in the light for a long time. Therefore:

Wear sun goggles if you have to look into reflections for a long time

For the usual cooking there is no need to do this, as the pot should be (painted) black and most light is hitting the pot and converted to heat without much reflections. During the best cooking hours around noon the mirror is about horizontal and most light hits the pot from the bottom, but in the morning and evening hours when the cooker has to set up upright to catch the sunlight the upper half of the mirror is above the pot and sends light from top into the pot. If the food to cook has a bright colour (like unroasted coffee beans) the food might shine very bright, causing a little pain at the beginning when you start looking onto it. If you need to look into the bright reflecting food for a long time you should wear sun glasses as well! Therefore:

Wear sun goggles if you have to look for a long time onto something bright placed in the focal area

This especially important if you place a white sheet of paper into the focal area to test if the cooker is good made and right adjusted. You have to look onto the paper until it burns, not to burn your fingers. Keep in mind that it is about 200°C in the focal area even if you can't see any fire! So don't touch the metal supports in the cooking area with bare hands. Therefore:

Use gloves or a thick dry cloth around your fingers if you touch hot metal parts in the focal area

And because hot parts may accidentally fall down and it is easier to place the cooker in position:

Place the cooker on clean and level ground without dry grass or other which may burn easy

And here is the last safety rule to protect the cooker and avoid any reflections when the cooker is not used and to protect the cooker from rain, dust and playing children:

Put the mirror of the cooker upside down when not used

and fix it in that position, so it looks like an umbrella. The cooker is also very stable to wind action in this position.

Safety is a very important issue as wrong handling and a single bad experience may spoil all success of the introduction of solar cooking. So, if you from your practical experience know more operation ore safety rules, please mail to: amsi-solar@gmx.net

[Table of Contents](#) or learn more about [placing](#) the cooker, [adjusting](#) the cooker or about [cleaning](#) and maintenance

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Cooking Rules

and Procedures

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EG SOLAR

Entwicklungshilfegruppe Solarkocher der Staatl. Berufsschule Altötting e. V.

Solar cooker development group of the governmental technical college in Altoetting

- [Go to EG-SOLAR homepage \(in German Language\)](#)

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Project

Pictures

Here are several pictures with explanations concerning the AMSI project and the special situation in Ethiopia:

- [The modified EG-SOLAR SK14 solar cooker](#) adopted to rough handling und local constraints
 - [Making the AMSI solar cooker](#) using a wood model
 - [Teaching metall workers](#) to build the AMSI solar cooker
 - [Teaching](#) the principles of solar cooking
 - [Carrying Firewood](#) is womans work, and very very hard
 - [Deforestation and Erosion](#)
 - [Roasting coffee beans](#) on the solar cooker
 - [Using the traditional Jabenna](#) for cooking coffee
-

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Other Projects in Ethiopia

There are not many activities, supporting Solar Cooking in Ethiopia. Probably I'm not good enough informed about activities.

At least I hope so, as there is probably no other country with higher demand of saving firewood and better sun conditions at the same time.

- arcarana, Solar Energy for Ethiopia, René Achermann, arcarana@spectrawe.ch , Neumattstraße 17, CH-6048 Horw, Swizzerland, Phone 0041-3420547, Fax 0041-3420548 (<http://www.arcarana.ch/solar.html>)
- SELAM Technical & Vocational Center, P.O. Box 8075, Addis Ababa, Ethiopia, Tel. 00251 1 60 14 81, Fax 00251 1 60 14 79
E-Mail: davidr@telecom.net.et (<http://www.selam.ch> , <http://www.selam-eth.de>)
- Care-Ethiopia, Senbet Elmo, Addis Abeba, Ethiopia, Fax 00251-1-611900, or Nazareth Phone 00251-2-113362
- Hope Enterprise, Aberra Regassa, P.O.Box 30153, Addis Abeba, Ethiopia, Phone 00251-1-711800, Fax 00251-1-711088
GTZ (German Technical Aid) Office Addis Ababa, P.O.Box 12631, Ethiopia, Phone: +251-1-653 782, 653 819, Fax: +251-1-654 104, E-Mail: gtz-aethiopien@et.gtz.de
<http://www.gtz.de/home/english/index.html> and [GTZ-Projects in Ethiopia](#)
- Agro Action, World Food Program <http://www.wfp.org/ethiop>

I lived only for two years in Ethiopia and my knowledge of other solar cooking projects is mainly based on rumors I heard. So any contributions to complete the following poor list of activities and addresses are welcome!

[Table of contents](#) or [List of Project Pictures](#)

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Related

Links

If you are interested in any aspect of cooking with sunlight don't miss to check the most complete collection on solar cooking: <http://solarcooking.org> the solar cooking archive.

If you are interested in the roots of the AMSI-Solar-Cooker check the following site (German language):

- <http://www.eg-solar.de>

If you are interested how to cool food and freeze water using the AMSI-Solar-Cooker check here:

- http://www.zeo-tech.de/e_index.htm (Click on Solar Cooling)

If you are interested in further Information about Ethiopia follow these links:

- <http://www.dse.de/za/lis/aethiop/homepage.htm> (German site with some links to English pages)
- http://www.deutsch-aethiopischer-verein.de/what_is_gea.htm (German -Ethiopian Assosiation)
- <http://www.ethemb.se/ngo.htm> List of Indigenous and International NGOs Currently Working in Ethiopia

The low risc of eye injuries caused by looking into sunlight for a short time is discussed here:

- <http://mintaka.sdsu.edu/GF/vision/Galileo.html>

***** More unsorted und unclassified links related to solar cooking *****

1. [BlackWoods Home](#)
2. [Review of Solar Cooker Designs](#)
3. [The Solar Cooker Falco S/C°](#)
4. [Solar Cooking \(Japanese Site\), English](#)
5. [Solar Water Pasteurizers](#)
6. [OSOW, Solar Cooking Projects Worldwide](#)
7. [Global Sun Oven \(Commercial\)](#)
8. [BSW, Förderverein für Entwicklungsländer e.v., German](#)
9. [The SOLAR NOW Project](#)
10. [Tamara's Solar Cooking Pages](#)
11. [Solar Energy Cooker in Mount Abu \(India\), English](#)
12. [Solar Oven Project](#)
13. [Jurasol Australia](#)
14. [Solar Cooker made of Clay](#)
15. [Technology Professionals for Life \(Finnish\), English, Finnish](#)
16. [The Kona Cooker \(Commercial\)](#)
17. [Solar Cookers in South Africa](#)
18. [Different Utilities Using the Sun](#)
19. [The ULOG Solar Box Cooker, English, German](#)
20. [Making the ULOG Cooker, German](#)
21. [Solar Concentrators](#)
22. [Links and Resources for Energy and the Environment \(Texas\)](#)
23. [Verein zur Verbreitung von Solartechnik in Entwicklungsländern e.v., German](#)
24. [Aluminium for reflectors \(ALANOD Company\)](#)
25. [Using a Sterling Motor to produce Electric Energy](#)
26. [Union of Concerned Scientists](#)
27. [Kochen und Backen mit Solarkochern \(German\)](#)
28. [Sun Utility Network](#)
29. [Sun Oven Recipes](#)
30. [Solarserver, \(German, English\)](#)
31. [Solar Energy International](#)
32. [Solar Cooks do it in the Sun](#)
33. [David Delaneys Project \(Lid Compare\)](#)

34. [International Solar Energy Society \(ISES\)](#)

Solar Cooker

[The Solar Cooking Archive](#)

[Tekniikka Elämää Palvelemaan, Technology for Life](#)

[Family Fun With Renewable Energy](#)

[Small Power Systems](#)

[The First Solar Convection Oven](#)

[SOLAR COOKING](#)

[Solar Cooking Plans](#)

[Crockpot Recipe Index - Over 1000 Recipes - Southern U.S. Cuisine](#)

[Solar Cooking](#)

[Solar Oven @ CCAT](#)

[Amazing Solar Chef High Performance Solar Oven](#)

[The Solar Barbecue](#)

[Solar Cooks Do it in the SUN!](#)

[Sun Oven Solar Power Solar Energy](#)

<http://www.accessone.com/~sbcn/fi/petri.htm>

[Solar Cooker Home Page](#)

[Solar Energy International - Renewable Energy Education & Sustainable Development](#)

[Real Goods Trading Corporation - Helping people create renewable, energy-powered, eco-friendly and sustainable living in an energy efficiency environment.](#)

[High-Performance Thermoelectric Cooling Devices Made by Tellurex Corporation](#)

[Thermoelectric Remote Power Supplies By Power Source, Inc.](#)

[Solar Energy: World Distribution](#)

[ClearDomeSolar.com](#)

[Topica, Free Email List Services](#)

[Welcome to Tripod](#)

[Welcome to ULOG](#)

[The Solar Cooking Archive](#)

[How to Make and Use the Solar Funnel Cooker](#)

[ClearDomeSolar.com](#)

[Willkommen bei ALANOD Aluminium-Veredlung GmbH & Co - ONLINE -](#)

[Tekniikka Elämää Palvelemaan, Technology for Life](#)

[Coming soon](#)

[Enigma On-line](#)

[Solar Energy International - Renewable Energy Education & Sustainable Development](#)

[Review of solar cookers designs](#)

[International Directory Of Solar Cooking Promoters](#)

[The Solar Barbecue](#)

[ClearDomeSolar.com](#)

[Review of solar cookers designs](#)

[Improvising a Greenhouse Pot for Solar Panel Cooking](#)

[SolarShop](#)

[Safe Water Systems Home Page](#)

[SunLightWorks, Inc. -It's Clean, Safe and Free, Use It!](#)

[Making and using a solar cooker by Joe Radabaugh Issue 30](#)

[Solar Cooker Home Page](#)

[No title](#)

[Solatube International: The Industry Leader in Tubular Skylights](#)

[Solar-storage](#)

[Surface Solar Energy Data Set](#)

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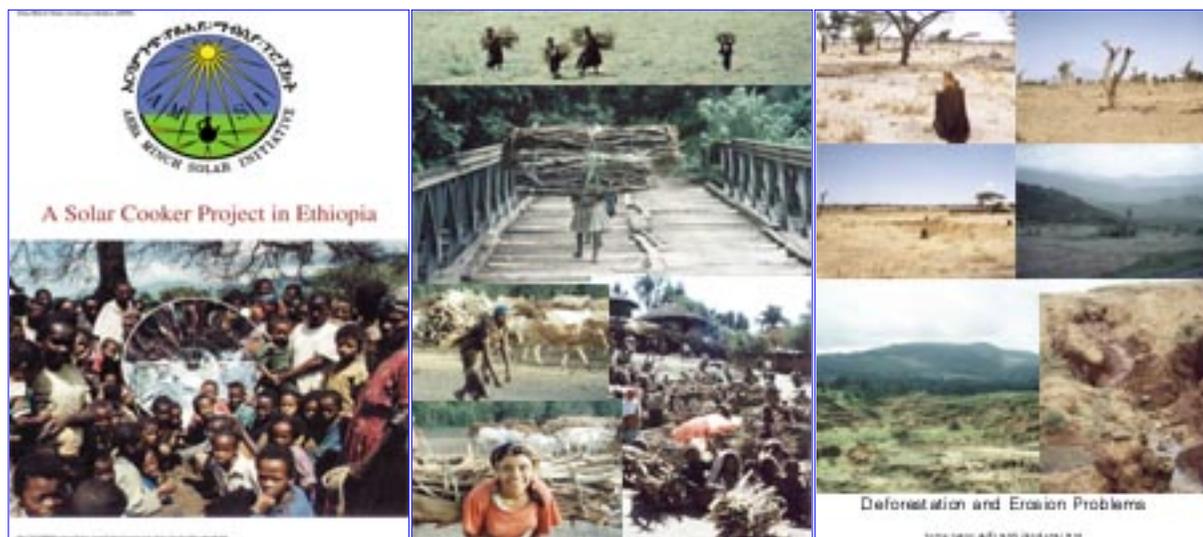
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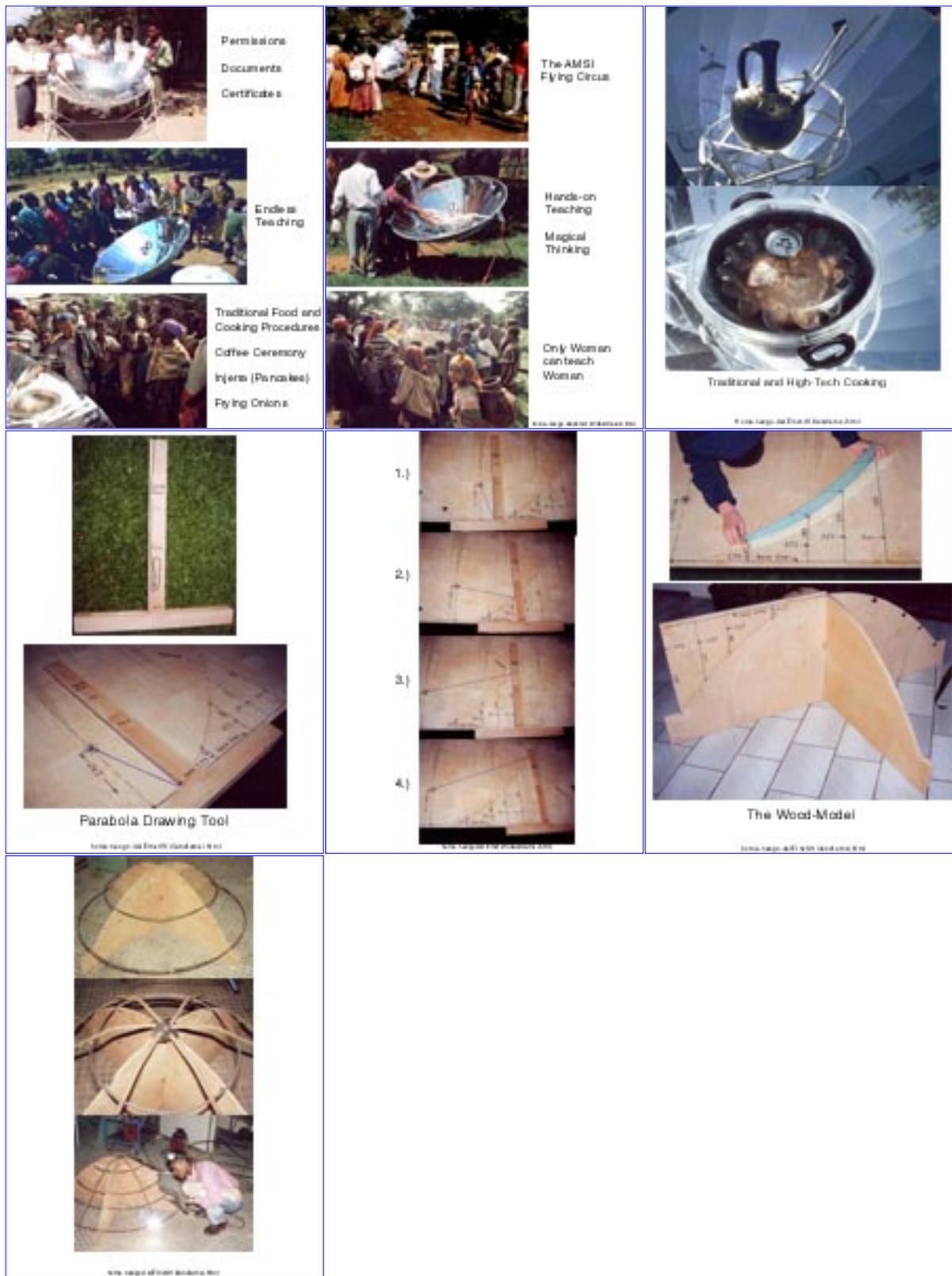


9. Int. Conference on Solar Cooking

The Arba Minch Solar Cooking Initiative was presented at the 9. International Conference on Solar Cooking which took place at the 24. and 25 of March 2001 in Burghausen (Germany). As several people asked me to get a copy of some of the transparencies used at my presentation, I have placed them here for download.

Klick on the thumbnail pictures to get a high resolution PDF-file (in Acrobat-Reader format).





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