How to make a solar campfire

Introduction: The solar campfire is one of the four options for a 'message carrier' of the 'scouts go solar' project. It is best combined with a solar suitcase, i.e. use the solar suitcase as power source for a 12V DC campfire. With the available power of a solar suitcase, we can build 'flames' of 60cm – 1m height.

An electrical or solar campfire might sound like a strange idea. Still, electrical fire is already used by scouts with very young kids for safety reasons and can be an alternative in areas where open fire is prohibited. Or just enjoy the 'strangeness' of it!

If you desire a smaller and independent system, you can build a 5V campfire with rechargeable batteries and a 6V solar panel. It will be much smaller than the 12V model, the flame can be some 30cm high.

While we have rather precise instructions how to make a solar suitcase, the solar campfire is still under development and this text can only be a rough guide how to build it. Use your imagination to make it more impressive and introduce your ideas[1]!

1 And don't forget to share them on the 'scouts go solar' facebook page!

A) Materials list

You need the following materials to build your solar campfire. Some of them you can find in an electronics shop, in a hardware store, in a paint shop, in a fabric store or in the internet (ebay.com, aliexpress.com , etc.).

Part	*Specification*	*Comment*
Fan(s)	12V DC, (combined) power of 15 – 30W, good quality	There are large differences in the efficiency of fans. Try to find a good quality model.
Fabric for outer flame	Yellow (or yellow and orange and red), ultralight and transparent fabric, about 2m x 1m	Use the most lightweight fabric you can find!
Fabric for inner flames	Yellow, orange, red bits of ultralight fabric. Buy fluorescent fabric if you can find it! About 1m x 1m	Use the most lightweight fabric you can find! A good option is an ultralight nylon net used for decoration (and for little girl's tutus).
Option: replace fabrics by orange cellophane		Crumble the cellophane and illuminate it with the coloured LEDs.
Option: replace fabric by silk paper		Silk paper is more rigid, you can create a 'self standing' flame. It will not be very durable.
Red, orange, blue, white LED strips	12V DC LED strips (one colour per strip), to be bought per meter or per roll	Car electricity shop or Ebay.com
Option: replace LED strips by single LEDs		Use the LEDs by 'triplets', i.e. connect 3 equal LEDs in a row and add a resistor to adapt the voltage[2].
UV LED strips (optional)	12V DC LED strips with UV LEDs, to be bought per meter or per roll	Ebay.com
Firewood logs	Real firewood	Replace with printed logs on cardboard for lighter weight
Charcoal, burnt or painted log	Real bits of burnt wood from fireplace or charcoal or log painted black	Replace with drawing of burnt logs for lighter weight.

2 You need to know the current (Amperes) of your LEDs and their voltage (depends on the colour) and calculate the resistor using Ohm's law V = R*I as explained in chapter H.

Fluorescent paint (optional)	Orange or yellow fluorescent paint	From specialised paint shop.
Orange and other paint (optional)	Acrylic paint	To decorate logs and charcoal
Iron wire, tacks/pins, nails, glue, ...		
Sewing thread and needle		
Plywood, etc.	Anything to create a base to attach the fan, the LEDs and the fabric	

Lightweight transparent fabric.

12V fans and cigarette lighter plug.

LED strips (plus some single LEDs on the left).

B) How does the campfire work?

In order to simulate the effect of a fire, we create a flame of fabric which is blown upwards with the help of a fan, similar to artificial flames which are used to decorate restaurants and discotheques.

It needs less power to inflate a 'bag' than to keep a single bit of fabric pointing upwards on the fan. This is why we first sew a flame in the shape of an inflatable bag; we use transparent yellow fabric. This outer flame does only move little in the 'wind' of the fan.

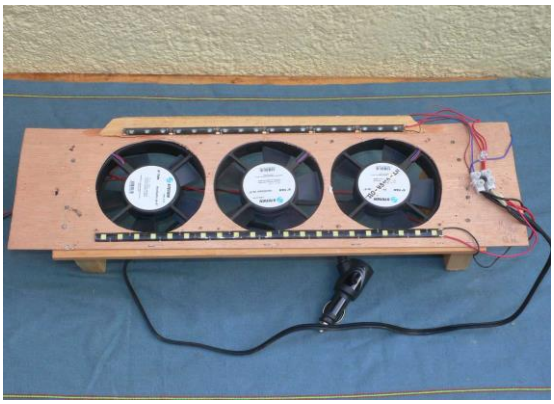
Inside the large flame there are small bits of (normal or fluorescent) yellow and orange fabric which are in constant movement. All fabric must be extremely lightweight in order to make it move or point upwards with a relatively small fan.

For the light effect, there are yellow, red and some blue LEDs installed. A more impressive effect is created using UV or blue LEDs and fluorescent fabric and paintings. Unluckily paintings are in general too heavy to use them on the fabric (it will not 'fly' any more), so we can only use it on the solid lower part of the campfire.

In the lower part we hide the fan by logs of (real) firewood and decorate the campfire with charcoal, orange paint etc.

C) The base structure

You need to create a base where to attach the fan, the LEDs and the flames. It must be some 10cm above the ground in order for the air to flow towards the fan. A good idea is a plywood plate to which you attach some 'legs'. You can saw a hole or holes for the fan(s). Attach the fan(s) with screws and connect it/them[3] with two wires (plus and minus) to a 12V cigarette lighter plug. Its a good idea to use a cigarette lighter plug which has an integrated fuse or add a (car) fuse in the plus wire (5A rating).



D) The outer flame

Saw the outer flame in the shape of a 'bag' with one ore some small openings at the highest part for the air to get out. Use very lightweight transparent fabric. You can use a single colour (yellow) or combine colours like the flame in the picture.
Attach it to the base plate in a tight way. The only openings of the bag are the fan itself and the outlets at the top of the flame. Try different sizes of flames to find out how large a flame your fan can 'lift'. (In our case, three fans of 5W – in total 15W – were able to keep a flame of about 70cm in the air. A flame of 1m needed 30W of fan power)

3 If you use several fans, all plus wires come together. The same for the negative side - all minus wires come together.

E) The inner flames

Using a 'bag' with an inlet below and an outlet above we create a guided airflow inside. Cut bits of orange and red fabric (they might be fluorescent, see chapter E) to create long and thin flames which you glue or attach to the base plate *inside* the larger flame. It needs some trials to find out how many inner flames your fan can keep moving.

In the picture the inner flames are attached to the base structure, the outer flame has been taken off.

F) The firewood decoration

Decorate the lower part of your campfire with real wood logs outside and burnt (or painted black) logs or charcoal inside (and hide the fan(s) at the same time). Be very careful to leave enough air inlets below the fan(s). The better the air can get to the fan, the better it lifts the flame! Create the effect of hot charcoal adding orange 'glitter' paint at some points (the paint might be fluorescent, see chapter E)

If you want a lightweight model, replace the wood with prints or drawings of firewood on cardboard and glue it around the base plate.

Decoration material.

Very first trial of campfire with firewood print

Campfire with cellophane flame and wood logs.



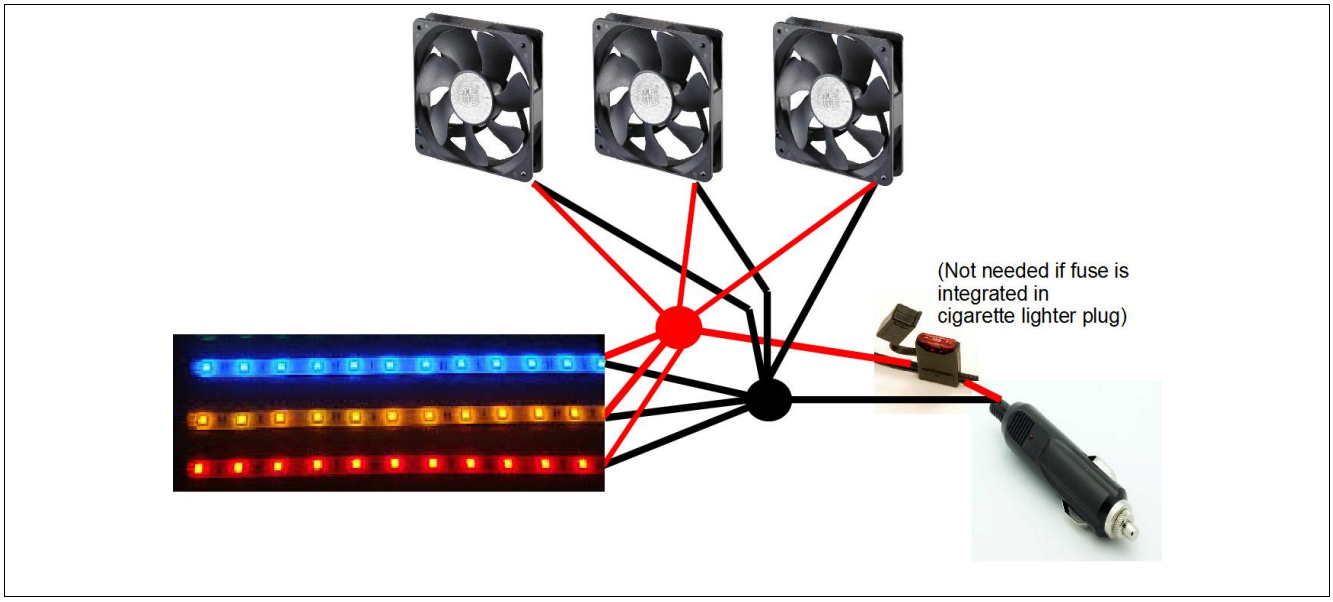
Different campfires decorated with real wood logs from fireplaces.

G) Lights

The campfire should 'glow' at night. Cut bits (some 20cm) of the LED strips (cut at the marked places only!), solder 2 bits of wire to each strip (best use red and black to indicate polarity) and glue them in a way that they either illuminate the flame (from inside) or the charcoal. Point red and blue LEDs to the charcoal and red, orange and yellow LEDs towards the flame.
You can also illuminate the campfire with white LEDs. They are stronger and your campfire will be brighter. On the other hand the white light affects the effect of the coloured LEDs. If you use fluorescent effects in your flame, the use of white LEDs is not advised.

For the electrical connection, at some point all positive wires must come together and be connected to the 12V power cable and the positive wire of the fan. The same holds true for all negative wires.

Schema of the electrical connections:



H) UV or blue light and fluorescent fabrics and paints

Fluorescent fabrics and paints glow nicely at night if they are illuminated by UV or blue light. You can buy fluorescent fabrics[4] in the internet or in decoration / 'dressing up' shops. Fluorescent paint is available in a good paint store or in a stationary (paper shop). Unluckily all paints are relatively heavy – if you paint on the fabric which is blown upwards it will probably not 'fly' any more. Use paint on the solid parts in the lower part of the campfire.
Fluorescent effects are usually created with UV light. In reality, most blue LEDs make fluorescent colours 'glow' as well. Try both types of LEDs if you have them at hand.
We use UV or blue LEDs which are not very strong. They should be placed as near as possible to the fluorescent element. In one prototype we glued them onto a thin metal arc inside the flame to have place them nearer to the fabric (see the picture in section B). Ideally, UV light should only point towards the 'glowing' elements and not to the outside, as the light is bad for the eyes of the scouts sitting around the fire. (You can try to shade the LEDs on the outwards side.)

I) Other decorations and effects

Feel free to integrate other decorations, paintings, sound effects, etc. etc. to your campfire! Let us know about your inventions[5]!

J) Use of other materials and ideas for the flame

The scouts of the Philippines make electrical campfires using orange and red 'cellophane' which is crumbled and cut in the shape of flames. They illuminate it with a spot and use a strong room fan below.

Another lightweight material is silk paper. It can be used with a very small fan as it is partly rigid and the flame can 'stand' on its own. The flame will probably not survive several transports or an occasional rain as the material isn't very solid.

In one experiment, we installed thin metal wires to 'hold' the tip of the flames. That way, we could build a campfire without outer flame. It is not easy to hide the wires...

4 Some are called 'decorative net'.

5 We will be pleased to get a picture or short video at the 'scouts go solar' facebook page.

Cellophane and silk paper. *Flame of silk paper.* *Large cellophane flame.*

Flames held by metal wires.

K) The one meter model at the 23rd World Scout Jamboree

At the 23WSJ, we built a larger model with a flame of one meter height. It needed 8 fans of 5W to keep the flame 'flying'. We used a PV system with a larger battery. In one campfire night, a Swiss group used it from 20h to a little after midnight, when the charge controller stopped it due to low voltage.
Our experience showed that the campfire is not very impressive at daytime (although you can shoot nice pictures), but at night time with the light effects working, everybody liked it a lot. Some pictures:

The base plate with fans and a metal grid to avoid that bits of fabric enter the fans.

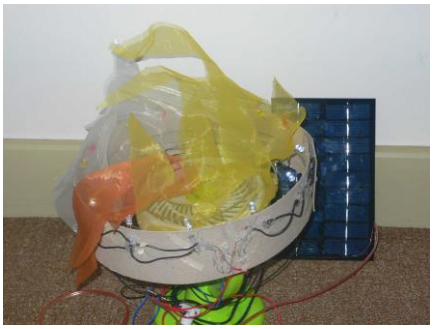
A metal grid serves as a stand for the campfire (to allow airflow below the fans).

Lights on!

Impressions of a campfire night with a Swiss group at the 23rd World Scout Jamboree.

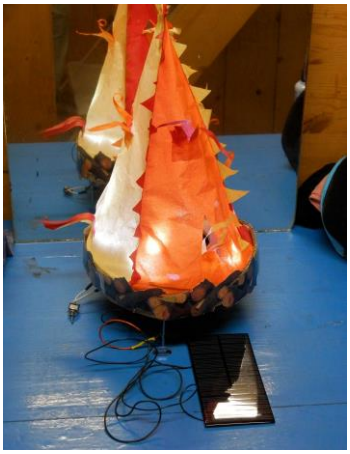
L) The small, independent model

Make an independent small campfire building it as above, but with a much smaller flame. Use either small 6V fans (ebay.com) or USB fans[6] (computer accessories). Store the energy in four NiM:H rechargeable batteries (For instance AA size in a four battery box), the system voltage will be about 5V. Charge them by a 6V solar panel which is connected passing through a Schottky diode.



First trials: Flames attached to USB fan (with its own stand), LEDs glued to a cardboard ring.

Materials for the independent model.

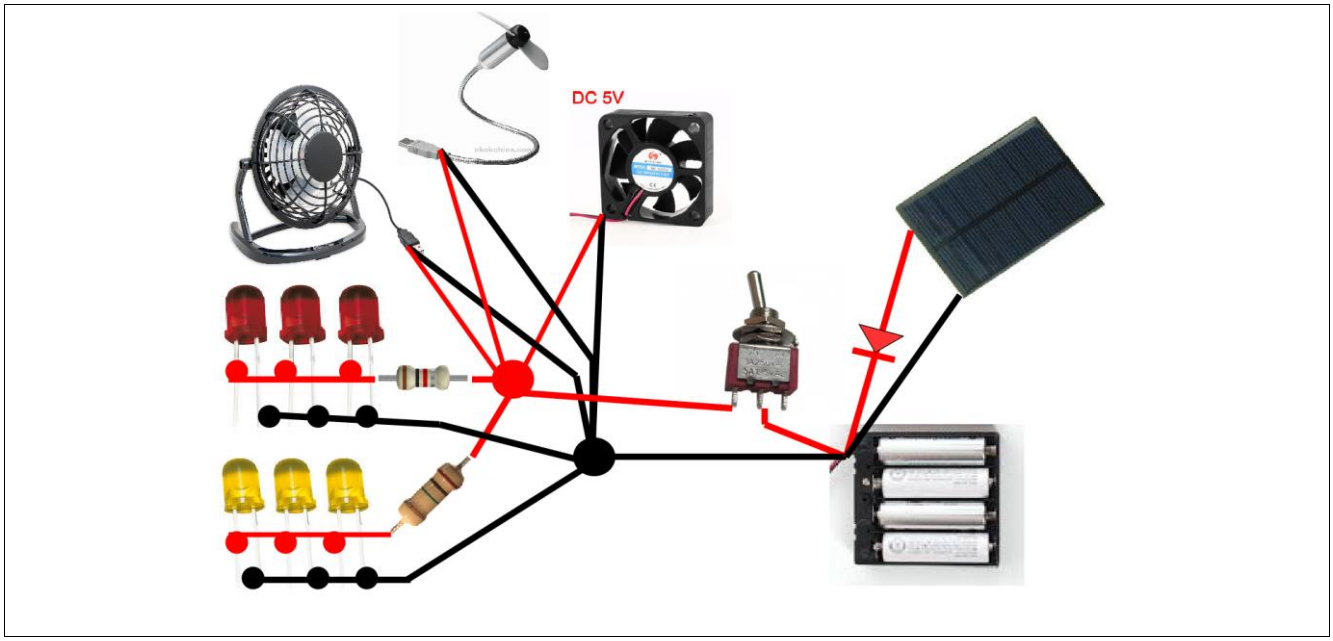


Small solar campfire with silk paper flame.

As the voltage is lower than for the large model, we cannot use 12V LED strips, but must use single LEDs. All LEDs must be connected through a correctly sized resistor. As for the larger model, at some point all positive connections come together and are connected to the plus side of the battery box (do not forget to place an interrupter in this wire). Equally all negative wires are connected to the minus pole of the battery box.
The solar panel is connected to the battery box as well; the plus wire is interrupted by a Schottky diode (1A rated). Be careful with the polarity: the diode's grey ring is pointing towards the battery box.

6 To connect them to the battery box, you can cut their USB plug or find a female USB connector.

Schema of the electrical connections:



How to calculate the resistor for the LED(s)? You must know the voltage of your LED (typically 3,6V for white, 2 V for red, 2 V for yellow, 3,5 V for blue and 3,6 V for UV) and the current rating (in mA). You must choose a resistor which 'eliminates' the difference of voltage between your LED and the system voltage. Calculate it using Ohm's law V = R*I.
An example: The difference of voltage between a white LED (3,6V) and our batteries (5V) is 1,4V. A single round (diameter 5mm) LED rated 20mA needs a resistor of R = V / I = 1,4V / 0,02A = 70 ohms[7]. In order to use less resistors, you can group LEDs of the same type connecting them in parallel (all plus together, all minus together). The current adds up, the voltage does not change. Example: Four 5mm LEDs rated 20mA each use 80mA together. The group needs **one** resistor of R = V / I = 1,4V / 0,08A = 17,5 ohms.

Michael Götz, 12/05/15 and 7/1/16

7 You will probably not find the exact value you need. Choose the nearest value you find (rather a bit too high than too low).