Asian Hornet Beekeepers Guide – The Electric Harp / Harpe Electrique / Arpa Electrica – April 2023 revision

By Cambridgeshire Beekeeper Andrew Durham

In this article I am looking in detail at one of the most effective measures for reducing the Asian hornet's predation on the hive; the *Harpe Electrique* as it is known in France or the *Arpa Electrica* as it is called in Spain. The "harp" is a grid of electrified wires that stuns the hornet flying through the grid, causing it to fall into either a water-bath or into a trapping chamber.

In Spain the *arpa* was endorsed by Dr Sandra Rojas-Nossa of the University of Vigo following a field trial (see extract below). A further and more detailed study "Effectiveness of electric harps in reducing Vespa velutina predation pressure and consequences for honey bee colony development" (Article *in* Pest Management Science · August 2022 - DOI: 10.1002/ps.7132) concluded that "Electric harps contribute significantly to mitigate the impact of this invasive hornet on apiaries".

The electric harp is not a stand-alone solution, it needs to be deployed alongside other devices such as the "museliere" or muzzle, the 5.5mm hornet entrance restrictor and traps in the apiary. It should part of an integrated defence against the hornet that includes the spring trapping of foundress queens, the identification and destruction of the hornet's first nest ("nid primaries") and the reporting and destruction (by experts) of the hornet's main or secondary nests.

In the apiary the harp can either supplement trapping using baited traps or (as some Spanish experts would argue) replace other trapping entirely, thus reducing the apiary's olfactory signature.

Proven to be both effective and selective, care has nonetheless to be taken in the selection and deployment of this piece of equipment; and so in this paper we will look at all aspects of including procurement, DIY construction, and powering the harp in the apiary.

Why use the *harpe* / *arpa* at all?

As the Asian hornet's predation of the hive increases during August and develops into a serious problem in September and October, there is an urgent need to reduce the stress on the bees and this can be achieved with two complementary measures, the museliere (muzzle) and the harpe/arpa. The former provides a protective zone immediately in front of the hive entrance, significantly reducing the stress on the bees, but it does nothing to reduce the scale of the attack.

Dr. Sandra Rojas Nossa PhD

Department of Ecology and Animal Biology, University of Vigo reporting on a field study to assess the effectiveness of the « arpa electrica » (reported in Campo Galego by L.Martinez 10 February 2019.

"After 5 weeks of using the arpa, the reduction of Vespa velutina is very considerable and the pressure on the hive is reduced, while the number of bees that return to their functions increases, including foraging, fundamental for the survival of the colony "

The *harpe/arpa* has been found to be very effective at reducing the number of hornets predating in front of the hive and this has the consequential effect of reducing stress, reducing the size of the guard-force, increasing foraging and thus increasing colony survival.

What is the *harpe/arpa*?

The harp is a grid of fine wires strung in a rectangular frame; the wires are electrified by a high voltage (HV) charge that stuns the hornet causing it to fall into a water bath or trap below. The hornet does not see the wires, which are sufficiently distanced from each other (typically a 20mm gap) that a honeybee passes through unharmed. The wires are wired with alternate polarity across the grid (positive–negative-positive-negative etc.).

What Voltage to Use.

The voltage used varies between manufacturers and this is the first element of the specification that needs careful consideration. The first harps were French and voltages used were in the many thousands of volts. One HV power unit delivered between 10,000 – 15,000 volts albeit at a low current. Others generated half that voltage whilst Spanish units tended to use a lower voltage; as low as 1,500 volts.

A higher voltage unit may appear attractive to the user but the higher the voltage, the larger and more expensive the HV unit becomes, taking more power and introducing the likelihood of the supply wiring leaking current or the grid itself arcing out, thus rendering the harp useless.

The Spanish argue that a high voltage is not necessary to stun the hornet, paralyzing its flight muscles and causing it to fall into a trap or water-bath. Furthermore, a lower voltage opens the door to smaller capacity batteries and to solar power.

The Harp's Grid Wires.

The wires need to be stainless steel to avoid corrosion and the diameter of the wire may vary between 0.15mm diameter to 0.5mm diameter. As with the voltage, there are pro's and cons to be considered. The thicker wire stretches less over time, is more robust and connections are easier but requires a greater tension and thus stronger springs and frame. The thinner wire is more "invisible" and as long as the springs have been carefully matched can still retain tension even after many months. On balance, I would opt between the two and use 0.25mm stainless steel wire.

Balma (Toulouse).

"Able to trap dozens of Asian hornets every day, the electric harp, tested for a year by the municipality, has proven itself. That's why the town hall chose to invest in three additional harps, at 400 € each".

Figure 1: Spanish Arpa Electrica's by SANVE (Sanve.weebly.com) Dry arpa left and wet arpa right). Photograph courtesy of SANVE

Trapping chamber or Water bath or just the grid?

When the high voltage grid stuns the hornet, it either falls to the ground or clings to the wire. It may recover to fly off and there is a school of thought that even this is effective because the hornet learns to avoid the area, which is why it is recommended that the position of the *harpe electrique / arpa electrica* is changed from time to time. Of course, such hornets remain free to return or to predate outside the apiary and so most users incorporate either a water bath or a trapping chamber.

The water bath is effective at killing the hornet, especially if a shot of washing-up liquid is added (it reduces the surface tension that might otherwise allow the hornet to float on top). However, there may be an issue if the unit is placed in front of the hive-line and the bees decide to use it as a water supply. Some beekeepers have solved this problem by scenting the water with lemon juice. For this reason some units incorporate a dry trapping chamber from which any insects inadvertently caught by the grid may escape (see figure 1).

French or Spanish?

The French were first to use the harpe electrique but the Spanish have caught up very quickly and some would argue have left the French trailing. This is evident in two respects:

Firstly, the *arpa electricas* featured in figure 1 above cost significantly less than their French equivalent, the biggest difference being in the cost of the HV power unit. A typical Spanish arpa from the SANVE range would cost 69 euros for an 80cm wet arpa + 70 euros power unit and 88 euros for a 80cm dry arpa (arpa only). This is comparable with a French *harpe electrique* from ApiProtection at 88 euros but the HV power unit is 185 euros (you can buy a complete Api-Protection *harpe* with HV power unit for 274 -297 euros (excluding 12V battery). To both you must add shipping plus any tax now that the UK is not in the EU.

Note: Google "Sanve weebly" or go to: https://sanve.weebly.com/

Secondly, the Spanish range of *arpa's* is much greater. The arpa typically comes in "flat-pack" form and requires assembly (see figure 2 below).

Figure 2 - A SANVE Arpa out of the box….. Photograph – A Durham

These are well engineered units that have withstood the vagaries of the English weather in my Cambridgeshire "test" apiary over two summers.

Tip: Sanve offer a video on YouTube demonstrating how to assemble its units and this is essential viewing: YouTube: Montaje arpa universal y agua A-60 y A-80, SANVE, Unboxing and assembly.

https://www.youtube.com/watch?v=oV_VEwiF1kc

WARNING

The electric harp presents a risk of electric shock. It is up to the reader to carry out their own risk assessment, taking into account where the harp(s) will be placed and the potential risk to both themselves and others. Appropriate barriers and warning signs should be used to prevent injury to those who might come into contact with the harp or its power unit.

The reader must decide for themselves whether they possess the electrical skill to construct the harp or its power supply system, or to modify any manufactured component.

PROCEED ONLY AT YOUR OWN RISK

The Harpe electrique / Arpa Electrica - system

Whilst I have given the detail below to enable the beekeeper to design their own *harpe* and power supply system, you need electrical skills to do the latter and you may wish to consider if it is cost effective in terms of your time and effort.

Let's say you wanted to buy two SANVE arpas at 140 euros plus shipping. On top of that cost there will be UK import duty (2.5%) and VAT (20%) on the cost of the arpa's plus shipping. Even with the extra duty and VAT, I think you will find it difficult to make the sort of harp in figure 3 below for less than that.

The Harpe electrique / Arpa Electrica – building the frame

You can make your own harpe (see figure 3) and designs are to be found on the internet (Google "Eric Le Bervet harpe electrique") http://adsa33.over-blog.com/2019/12/harpe-electrique-anti-frelon-presente-par-l-adsa33.html

But let's start with the components needed to build the harp shown in figure 3 below.

Figure 3: Home-made *harpe electrique* - Photograph: Andrew Durham

The frame is made of 1 ½" waste-water pipe available from any DIY store. The advantage of this is that the corners are "off-the-shelf" and just need cementing to the straight sections of pipe. But the pipe will not be strong enough on its own and it will be much easier to fix the wires to a threaded rod (10mm dia from a builder's merchant).

Harps typically come in 60cm – 80cm widths. Wider than that doesn't add anything and simply makes the frame weaker.

There is a problem to be avoided that goes to the heart of UNAF's early reservations about the *harpe electrique*. The grid's voltage may be high but the power or current is very low. Do not be tempted to use the threaded rods as conductors for the electrical current. It may seem okay when the rods are new but any corrosion between the galvanised rod and the grid wires will soon create dry joints that stop the current getting through. Use the rods to fix the grid wires and not for their electrical conductivity.

The tensioning of the wires is all important because loose wires can come too close to each other and either short out or catch bees. Avoid designs that use a continuous length of wire for either polarity. They may seem to offer an easy solution to the problem of potentially poor electrical joints but it is near impossible to maintain the correct tension on the wires across the grid and, with the inevitable stretching, they soon become slack.

Individually sprung wires are best; utilising a spring to get the right tension and a tie-wrap loop that serves two functions. It acts as an insulator at one end of the grid-wire and, if the wire stretches, the tie-wrap loop can be shortened to absorb any stretching in the wire (see figure 4 but with experience, I would now allow double the length of loop to that shown)

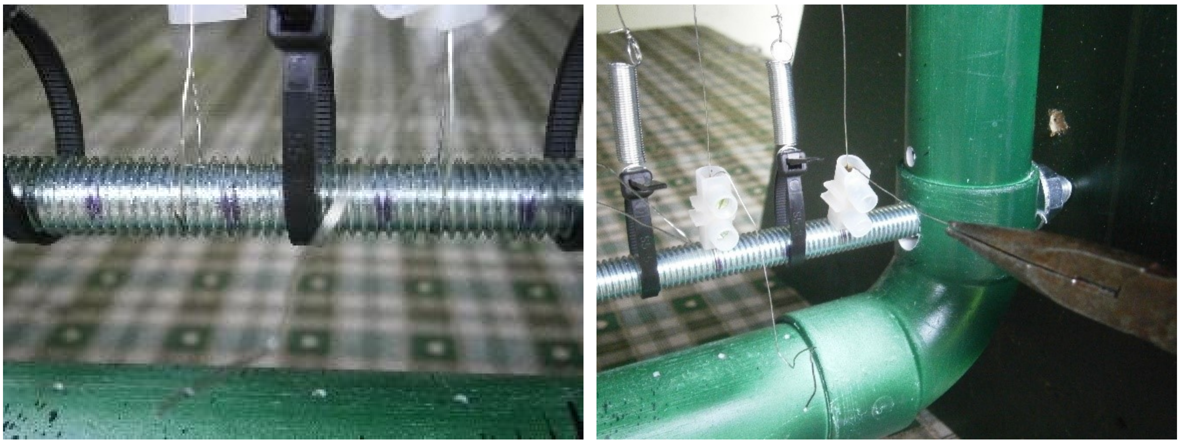


Figure 4. Allow enough of a loop to permit the wires to be adjusted along the rod (left) and do not fix the connector tight to the rod (right) Photographs – Andrew Durham

You will need stainless steel wire (Amazon), tie-wraps, electrical connectors as shown (B&Q) and springs (Halfords multi-pack). A pair of long nose pliers and an electrical screwdriver. If the harpe's frame is 80 cm wide internal dimension and the same in height then you will need 40 wires of at least 100cm length each so buy 50 metres of wire.

Find the centre point of each threaded rod and carefully mark out the rod each side of it every 20mm using a marker pen.

Remember the wires are going to alternate in polarity along each rod (see figure 5).

Each wire will have a tie-wrap passed through the end-loop of the spring, the tie wrap then being routed round the top or bottom bar as appropriate, before it is closed. Make sure you leave the tie-wrap loop big enough to give you room for adjustment if the wire stretches. Be consistent in your orientation of the tie-wraps and do not trim them yet.

Attach a length of wire to the other end-loop of the spring and tie-off securely using a non-slip knot. Pass the other end of the wire through the electrical connector (figure 4) before passing it around the other threaded rod and back through the electrical connector (do not tighten the connector yet and do not push the connector close to the bar but leave a loop large enough that you can move the wire along the threaded rod to position it on the mark – don't be tempted to shunt the connector onto the rod as has been done in figure 4 – right and in figure 5).

Using the pliers to grip the free end of the wire (the tail), tension the wire so that the spring is extended by no more than 50%, then pull the tail out as shown to get a good >90-degree bend whilst keeping the tension on the wire. Tighten the connector screw that is nearest the bar – **do not tighten the second screw at this point**. Make sure that the connector screw has tightened onto the wires or you will lose the tension and the spring will close up. Leave the tail for now and move onto the next wire in that polarity. Turn the harp upside down and do the wires for the other polarity.

When you have done all the grid-wires it is time to connect each polarity's grid wires together.

Starting at one end of each rod take the tail end of the first grid-wire and cut it to leave a free length of approximately 10cm.

Trim the tie-wraps to leave a 20mm tail that should be positioned to stick out as shown in figure 5.

Take the 10cm free length of the first wire and bend it to pass out and under the adjacent tie-wrap tail in a graceful bend, now bend the end of the tail back on itself so that you have a double wire to push down into the connector on the next wire of that polarity and tighten the second screw in the connector (the screw that you left untightened when fixing the wire to the rod). Working along the rod, do the same with each successive tail connecting it to the connector of next wire in the sequence etc.

Leave the free length of the last wire of each rod, bend it back on itself and tighten a connector to it so that you can later connect it to the positive or negative supply wire from the HV unit.

Check the tension on the springs and the gap, adjusting the wires as required.

Figure 5 – A section of a finished rod. Note how the connecting wires are looped under the tie-wrap tails. Note both the tie-wraps and connectors are too tight to the rod in this example. Note the routing of the connecting wire under the insulating tie-wraps. Photograph – Andrew Durham

The Harpe electrique / Arpa Electrica – the HV Power Unit

The high voltage on the grid wires must be generated by an electronic circuit board that converts a low voltage supply into the high voltage (HV) required for the wire grid (I'll call it the "HV power unit"). The supply voltage for the HV power unit comes from a battery, usually 12V, (with or without solar panel) or some manufacturers use an external mains supply (220/240 volts).

Note that one HV power unit can supply a number of harpes / arpas but if one is shorted out all the others will also be shorted out. In addition, runs of cable at high voltage between harpes/arpas tend to leak current. I recommend one power unit for each harpe/arpa; two at most.

WARNING

Do not use an electric fence controller. It is too powerful and the output is pulsed. That makes it unsuitable because a charge is required at the harps' grid at all times. However, note that a continuous output is inherently more dangerous so take care!

Making your own HV Power Unit

If you have the necessary electrical skills but only if you have those skills, it is quite possible to make your own HV power unit from an electric fly swatter. To do this you will need a 12 volt car battery (the battery in the swatter will not last long enough), a timer or photocell (so that the unit only operates in daylight hours), a 12 volt to 5 volt converter (Amazon) and a suitable fly-swatter (Amazon). Make sure the swatter is rechargeable using a USB lead.

It is important to have a decent voltage on the grid and so I selected, as a donor unit, an electric fly-swatter bat (£16) from Amazon.co.uk that delivers a claimed 3,600 volts, and that can be recharged from a USB output.

A challenge is to find the sometimes hidden screws that secure the fly-swatter, open it up and detach the paddle part, cutting the wires to it (coloured blue and red in figure 6 below) and connecting them into an electrical connector block, to which you will connect the supply wires to the harpe/arpa.

Important: Cut the wires to the bat's internal lithium battery – you want the only power to the grid to come from the external 5V USB power lead.

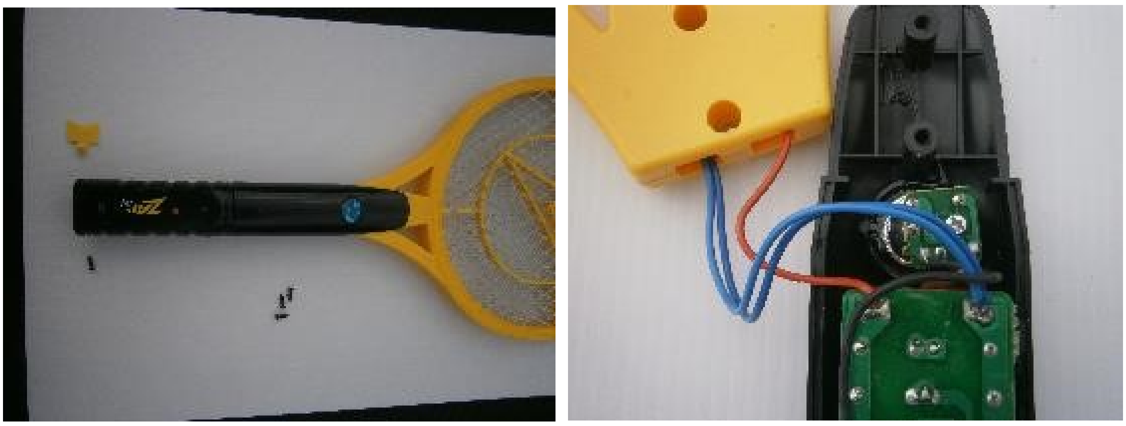


Figure 6 – Modification of an insect zapper bat. Photograph by Andrew Durham

Put the swatter back together (minus the paddle). Most if not all of these swatter bats have an on/off switch and also a push to operate (zap) button, which will have to be tie-wrapped down into the “on” position.

Because you are holding the push button in the “on” position and will have to leave the on/off switch in the “on” position and because you will put the Zapper into a weatherproof container, it will be permanently live while the unit is connected to an external power source.

It is good idea to use a double pole switch on the wires from the HV power unit output to the grid wired so that once the supply is disconnected, the capacitor’s supply to the grid can be shorted out.

Figure 7: Homemade HV power unit. Photograph by Andrew Durham Note: This was an early model that showed up the problem with using the threaded rods as electrical conductors. The red copper wires were a solution to the problem but nowadays I would not use copper wires for this purpose because they corrode. I would use stainless steel links as shown in figure 5 above.

WARNING – DANGER OF DEATH

The supply voltage to the insect zapper bat may be only 5 volts but an output of 3000 volts will give you a nasty shock and could kill you if the current crossed your heart.

Electric harpes/arpa’s and their HV supply units are potentially dangerous. Do not touch any of the exposed wires and do not move a unit that is switched on. Even when disconnected at the battery or switched off at the On/Off switch, the capacitor in the HV unit can retain its charge so it important to discharge the unit before handling by shorting out two of the grid wires.

ENSURE THE APPROPRIATE WARNING SIGN IS PLACED ON THE UNIT

Keep the HV supply leads to the harp's grid separated or they will leak current from the positive wire to the negative and you'll get very little output at the grid. Ordinary cables might be designed to insulate up to 400V but they won't stop leakage at 3,600V. It is quite possible with the more powerful French HV power units to get arcing between supply wires if you are not careful!

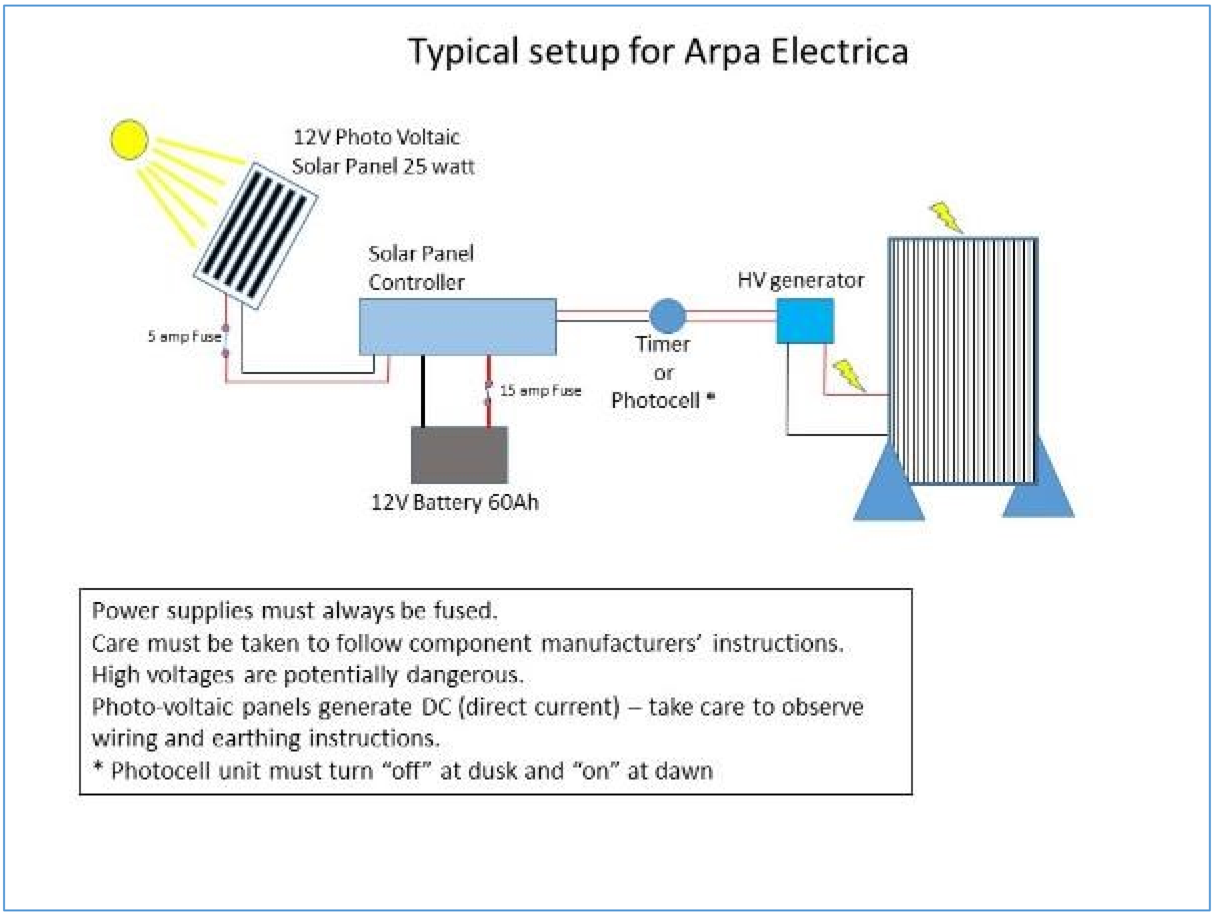
Powering the Arpa Electrica in the Apiary

Most apiaries do not have an outside electrical supply and so the HV unit will have to be powered by a battery (typically 12 volt leisure battery) that may be supplemented by a solar panel.

Be careful about buying a solar powered unit designed for Spain or southern France where the sunshine is stronger and more consistent. I suggest a panel with a 30 watt output for the UK but even then the battery may need to be periodically recharged off-site especially after a week of overcast skies.

Calculate the power demand of the equipment you wish to power in the apiary and it may be that a standard 12 volt car battery of around 35-40 AmpHr's will power everything for a week or more, especially if a 12V electronic timer is used (Amazon). The beekeeper may then choose whether to alternate a second battery or recharge the depleted battery overnight. This could be a much more cost effective alternative to a full solar power set-up (See Inset below – "Photovoltaic panels and batteries- doing the maths")

If the decision is made to use solar power to supply several harps, the set-up would look something like this and we will look at each component in turn (the HV power unit/generator was considered above).



The Photovoltaic Solar Panel

Photovoltaic panels are readily obtainable and we would be looking for one rated in Watts at a "nominal" 12 volts. "Nominal" because the voltage delivered varies widely dependent on the Sun. The voltage variation should not be a problem if the panel is connected to a 12V volt battery, the voltage of which is also nominal depending on the charge state of the battery. But if equipment is connected directly to the panel and especially if the panels are providing too much power, then the equipment can be damaged. In this instance it is wise to use a solar panel controller (see below).

WARNING

Solar Panels deliver DC voltage, which is more dangerous than AC. For DC voltages, currents above 25 mA at 50 V are considered hazardous under normal conditions

Figure 8: Two ECO-WORTHY 25 Watt 12 Volt Polycrystalline Solar Panel Modules providing solar power – Photograph by Andrew Durham (Note: One panel should suffice; a second can easily be added if required)

The Solar Panel Controller

There is an extra bit of kit that is usually required when operating solar panels, especially of $\geq$25 watt rating or more, and that is a solar charge controller. This controls the supply from the solar panel and battery and protects the battery from over-charging and over-discharge.

Take specialist advice if you decide not to use one.

SOLAR POWER

Photo-Voltaic panels are rated using a standard testing condition (STC) and the power is stated as watts.

However, the rated output can only be achieved if:

- The sun is shining!
- The panel is directly facing the sun.
- The sunshine is not diluted by haze or thin cloud

If the panel is set to face South, which is the norm, the sun will be shining on it at an oblique angle for much of the day and this can reduce the panel's output.

The panel should be mounted at angle of between 30-45 deg.

N.B. Any shade on any cells in the panel will reduce output.

It is best to plan on less than 50% of the rated output.

Sunshine hours are recorded for locations around the UK and for example, Norwich has some 200 hours in August, 150 in September and 125 in October; the months in which the arpa electrica would be deployed.

It is wise to always use the lower figure in such calculations i.e. 125 hours or an average of 4 hours of sunshine a day.

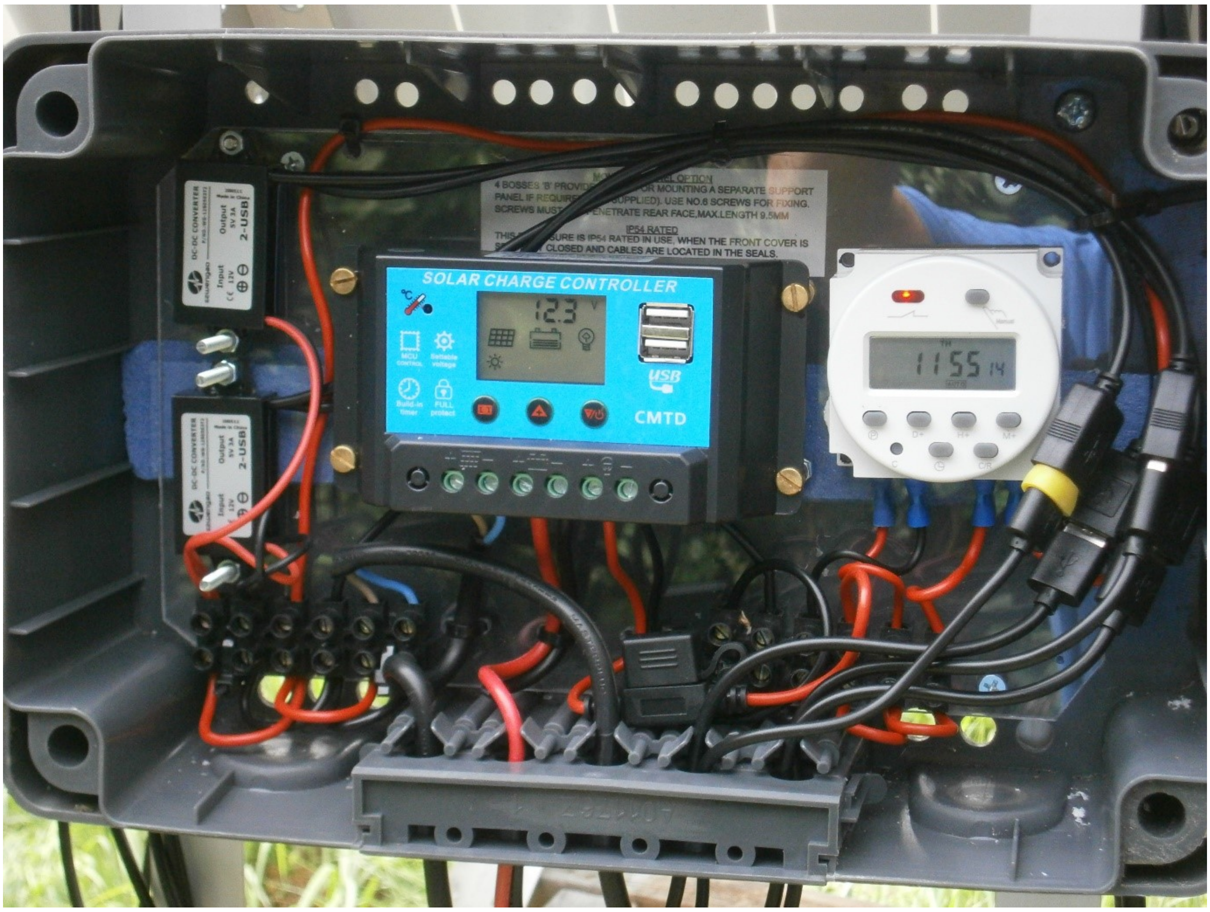


Figure 9: A Sunix® 20A 12V/24V Solar Charge Controller (£16.99 from Amazon) (note the addition of a 12V timer (right) and two 12v-5V USB converters (left) from Amazon. There are 4 x 5V USB outlets (far right) and a 12V output, all feeding harps. The USB sockets on the controller itself are not used because they are not controlled by the timer– Photograph - Andrew Durham

The importance of a timer…

There is no point in powering a *harpe* / *arpa* from dusk to dawn because the Asian hornet doesn't fly after dusk, so you may as well save your battery. Furthermore there is the risk that nocturnal flyers such as moths and bats could fly in the wires. A 12V timer is readily available from Amazon (see Figure 9 above. Alternatively, a photocell may be incorporated but make sure that the photocell does switch off at dusk and on at dawn, most stand-alone photocells are designed to do the opposite!

Photovoltaic panels and batteries – doing the maths….

The specification for your harpe / arpa's high voltage power unit will state:

- The supply voltage e.g. 6V, 12V, 24V
- The current drawn from the power supply, stated in amperes (A or amps)
- The discharge voltage at the grid (V) – we can ignore that from now on.

The battery will state its nominal voltage (V) and the capacity of the battery to supply that voltage over a number of hours (Ah).

Photovoltaic panels state their output in volts (V) and electrical power is stated in watts (W).

The HV power unit's power supply, battery, solar panel controller, and photo-voltaic panel's voltages must all match.

Example:

The high voltage power unit circuit requires a supply of 12volts and will draw from its supply a current of 0.5 amperes.

The battery must be a 12V battery (common in cars). If the battery is rated at 60Ah at a 1Ahr draw (amp-hours) it can supply the HV power unit for 120 hours (60Ah/0.5A=120 hours) but see below.

If the draw rate is not cited then a reasonable assumption is that the manufacturer is using the standard 20hr-rate i.e. the amps that will discharge the battery is 20hrs (known as C20). E.G. 60Ah battery at C20 will support a 3 amp draw for 20hours. However, one should not use more than 50% of the battery's capacity or risk ruining the battery, so its capacity is actually 30Ahr (or 60hrs supply to the HV power unit circuit).

The photovoltaic panel is rated at 25W (watts) at 12V (volts). In ideal sunshine conditions this will deliver a power of 2 amps (25W/12V= 2.08A) but this is unrealistic and we would be wise to rely on less than half that figure – say 1 amp (see inset panel Solar Power).

Our apiary's location is in Norwich which is recorded as having an average 125 hours of sunshine a month in September but only 100 hours in October (the two months when we really need our arpa to operate). We must use the October figure. We have ensured our system is on a timer so that it only operates for 10 hours a day in September and 8 hours a day in October.

The calculation will be:

HV power unit will demand 0.5A x 8hr/day x 30 (days) = 120Ahr total draw in October

Photo-voltaic panel will provide an assumed 1A x 100hr = 100Ahr total output in October (nominal deficit 20Ahr). To provide 120Ahr would require 1.2A output – whilst possible in theory, as there will be periods of no effective sunshine, the battery will be required for back-up.

Practical Solution: Use a 25W panel and 60Ahr battery, one can always add a second panel if required.