Light and Power

Using micro-power systems outdoors

Sheet **O.8**

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There are a lot of good things about technology: being able to make light at the flick of a switch is one; getting information and entertainment over the radio is another. This unit looks at how we can generate, store and use electricity outdoors using very small-scale micro-power systems.

A matter of scale

In this unit we look at the options for creating and using electricity outdoors using mobile micro-power systems – human powered and renewable energy systems that create very small (by comparison to your home) amounts of electricity to accomplish limited tasks: making light, running a radio, or charging batteries to put into other cordless devices. There are of course other, more traditional means of creating light, and we'll look at those too.

An awful lot of the information we see about renewable energy, especially renewable electricity, is about replacing conventional mains power supplies with renewable ones. Being outdoors, and trying to be as simple as possible, much of this information doesn't apply. You're not (hopefully!) going to be powering a TV and a fridge and so the scale of power demand is much lower, and this makes generating the power you need easier. More practically your set-up has to be light enough to easily carry, and this will ultimately limit the power that you have available.

Wind-up versus renewable

There's a lot of iconic baggage related to renewable energy. The very concept of “renewable” is often seen as an 'uncontested good', and so by association anything that incorporates renewable energy devices must also be good. In reality this isn't the case. There's a lot of kit out there, from mobile phone chargers to “mobile” (until you try to lift them!) solar suitcases, but not all of it is well designed or functionally useful. The same can be true of wind-up devices, but there is another issue that is rarely discussed; *is it better to go for wind-up or renewable?*

The reality of renewable technologies is that environmental energy sources are not very 'dense', and so small devices tend to produce very little power. On the other hand (no pun intended) wind-up devices can produce a lot of power for the amount of extra weight you're carrying. From experience, if you're seeking to minimise your use of resources, be it a torch or a radio, wind-up tends to work better for the amount of cost and weight involved. In fact, it's rather sad that human muscle power is the one form of renewable energy that the environmental movement seem reluctant to vigorously promote as an alternative to the “technological” (or lazy!) form of renewable energy.

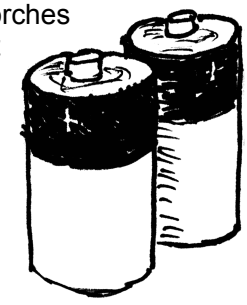
In this unit we cover both – renewable and wind-up power. Which one you adopt really depends upon your own needs and experiences. However, given that the most simple and portable form of renewable power is solar, if you're camping in Winter, or you're unlucky to have a run of bad weather, you'll probably find wind-up technology more reliable.

The need for light

Wall-to-wall, 24-hour lighting is a Twentieth Century artefact; before that people lived with much less artificial lighting and tended to plan their work around daylight as a result. In terms of the problems with our future energy supply, intense and pervasive lighting will have to be consigned to history because it's just so energy intensive to run. Lighting also has its disbenefits, the most obvious one being night-time light pollution which denies us our view of the stars.

When camping in the Summer you can get by with *no* artificial light sources at all. In most of Britain, if you rise at dawn and go to bed at dusk, you can get fourteen to sixteen hours of usable daylight – even more in northern Scotland. And in Winter, on a clear moonlit night you can walk around without a torch. So, considering the availability of usable daylight, *in most cases our need for artificial lighting should be designed by necessity, not out of habit*.

A small, low powered torch is sufficient to get by in Summertime if you organise yourself around natural light (wake at dawn/go to sleep at dusk). Outside of the Summer the options depend upon how you are organised. For one or two people, especially when trail walking, battery or wind-up torches are sufficient. In Winter you might have a problem because you will be spending more time in the dark. However, as camping in Winter, early Spring or late Autumn usually entails running a small fire for warmth, you'll have a small amount of light as a by-product of your heat source.



For a small group of people, especially if living in a static camp, you're likely to need a little more light. In these situations you might opt for a solar/wind charged micro-power system, as described at the end of the unit. A hard-wired system like this can be easily portable if the components are split up between everyone in the group, but if you're mobile the continual dismantling and re-assembly of the system can shorten the life of some components.

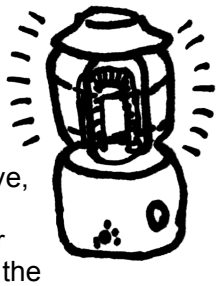
Options for making light

- ***Fire*** – Not a very practical option because to produce enough light to read by it'll be so big that the whole neighbourhood will notice! On a smaller scale, the fact that fire is also a heat source means that, out of season, sitting by firelight can be a more practical and spiritually rewarding means of providing enough light to eat, drink and be merry.
- ***Candles*** – Small, portable and they produce a small but useful amount of light. However to be safe in a tent and/or wind proof they need to be inside a lantern, which can be bulky and heavy (although you can get by with just a jam jar if you cut the candle down to fit inside). The main issue with candles is that they are 'non-renewable', and when they run out you'll need a fall-back option.
- ***Lamps*** – The next step on from candles, and producing more light, traditional oil lamps use purified paraffin burning inside a lantern or 'hurricane lamp'. They're easier to use than candles, but you have to carry the fuel, and there's no practical replacement when it's exhausted (petrol/heating oil are too sooty). Most importantly, the fumes produced from oil lamps make them unsuitable for use in an enclosed space like a tent.
- ***Torches*** (with disposable cell batteries) – Battery torches produce a lot of light, and are usually directional making them useful to see in the dark. The problems arise when the batteries run down; they're a pollution hazard to dispose of in the countryside, and of course you'll need to buy/carry some replacement cells (and carry the duds as 'dead weight').
- ***Torches*** (with rechargeable cell batteries) – Just as good at producing light, but the problem is recharging the batteries (or carrying spare batteries as 'dead weight'). Rechargeable batteries also have a lower capacity than disposable batteries and so you need more of them (usually about twice as many). However, the fact that the cells can be recharge 500 to 1000 times make them very much cheaper to use.
- ***Wind-up torches*** – Due to their potentially inexhaustible power supply (so long as you have food!) wind-up devices are great but their quality varies; only the more expensive LED-based ones are practical in terms of winding time because they are more efficient at turning electricity into usable light. The most useful feature you can have on a wind-up device is an external DC power supply, which allows them to be run or charged from a renewable energy source if you have one.
- ***Lanterns*** (rechargeable) – These come in two versions, rechargeable and wind-up. Usually a little more efficient than standard wind-up torches as they usually have LED/fluorescent bulbs and more complex electronics to manage power consumption. Obviously, they can be problematic to recharge, and the quality of the wind-up versions (in terms of winding to use time) varies a lot, and is usually reflected in the cost. Like torches, the most useful feature you can have on a wind-up device is an external DC power supply, which allows them to be run or charged from a renewable energy source if you have one (as described later in this unit).
- ***Low voltage fluorescent lighting*** – heavy, and requires an external battery pack that needs to be charged. They produce a lot of light, but that also requires a large power source to charge them, so it's only a practical option if you're able to haul a battery pack and large solar panel/wind turbine. They're usually not as efficient as wind-up lanterns because they're primarily developed for site campers and caravans. Using multiple wind-up lanterns powered from their DC sockets would produce as much light more efficiently, and you can vary the light level (turning one or two off) rather than just having the single lighting device turned either on or off.

Making light

There are all sorts of options to create artificial light (see the box on the left), and each has its benefits and problems. The main issue related to their use is something more practical – *weight*.

Sometimes weight isn't an issue. Candles and oil lamps are not practical for use in a tent and so you'll probably take a torch – in which case why bother to take the candles/oil lamp as well? But if you're planning to spend some time outside and it gets dark early candles and oil lamps can be a better option than the obvious alternative, a battery lantern.



Electric lighting is better for the restricted space of the tent, but you'll have to carry spare batteries or spend your time winding. However if you set your pattern around the daylight hours you won't need an awful lot of light, and so in these cases wind-up devices needn't be a problem (but they can be damn inconvenient when they run down in the middle of your night-time toilet break!).

When you include the additional cell batteries or liquid fuel, the baseline of efficiency for any source is how many hours use you get. It's important, given the time of year, to try and estimate how much time you're going to need the light source for:

- If you only want light intermittently, and for short periods, then electric or wind-up devices are obviously the solution;
- If you want light for long periods but not inside an enclosed space then any form of light will do but wind-up might become a little tedious (unless there are a few people camping together to share the duty between them);
- If you want light for inside a tent for longer periods then electric lighting is the best source.

A torch is the obvious light-producing device to take but they have a significant drawback; *they only shine light in one direction*. If you're moving around at night then shining the light in a narrow beam is more efficient to find your way, but in camp the uni-direction beam creates problems, especially when there's more than one person involved. So, if you're needing to walk cross country at night take a torch; otherwise get an electric lantern as the omni-direction light they produce is more useful in your tent, and around the camp.

In Summer lighting isn't essential. If you're taking a trip between the late Autumn and the early Spring then the shortage of daylight makes artificial light

more important. Whatever source you propose to take run it for a while before you go and measure roughly how many hours of light you get from it. Then sit down and work out, at *X* hours per day, how much you need. If you don't have enough time then you'll have to re-think your options.

Making noise

Sometimes it's nice just to disappear for a few days, and in these cases you might welcome “getting away from it all”. However, for longer trips, and for getting useful information such as the weather forecast, having a way of receiving radio broadcasts can be useful. You might also like to play music, and certainly on long, dark Winter nights a little music or a radio programme makes the time between nightfall and going to sleep pass a little more easily.

The options are very similar to lighting – either battery, wind-up, or using rechargeable cell batteries that you take with you. The significant difference is in application. Most low powered music devices use earphones and so only one person can hear them well – whilst the person next door just gets the annoying rhythmic hiss they create. For a group wind-up is clearly the better option because although it will need a little more attention, those sharing its output can take turns to wind it.

Generally, unless you're running a free festival, you don't want to be making a lot of noise – when you're on a site it's usually against the rules, and when you're wild camping it attracts attention. Also the more noise, especially low frequency bass beat, the more power you consume and so the more batteries you must carry or the more you must wind.

Options for making noise

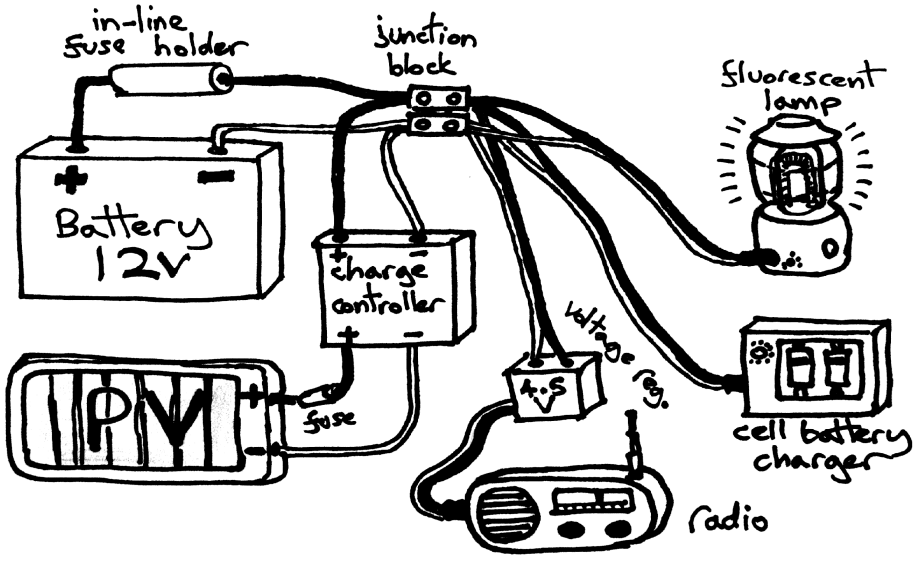
- ***Singing*** – Seriously, what do you think people did before radio? If you play a small musical instrument then you could take that along too.
- ***MP3*** – Small MP3 players (the small USB-type units, not IPods and the like which are more power hungry and must be recharged from the mains) are very efficient in terms of the amount of time you get music for in comparison to the amount of batteries used. Recent models also have such a huge memory capacity that you can play music for a few hours without repeating the same track. Also, don't just think music; you could get an audio book from the Library, 'rip' the CDs on the computer and load them onto your MP3 player. The only issue with MP3 players is that they can only be used by one person at a time.
- ***CD*** (cell battery powered) – CDs don't last as long as MP3 players, and they require you to carry the CDs to play, so they're not as good an option as MP3 players.
- ***Radio*** (cell battery powered) – A radio with batteries doesn't weigh more than the latest wind-up radios, and if it's small and quite quiet it will play for hours in a single set of batteries. As with torches you could use rechargeable cells, but they wouldn't last as long and you might have to carry spares.
- ***Radio*** (wind-up) – There's a wide range of wind-up radios to choose from. Some are louder than others, and some last longer than others for the same amount of winding, so it's probably a good idea to try some different models, or get feedback from web sites, before you buy. One of the recent problematic issues relates to digital radio. DAB radios use more power than the equivalent analogue radio. Whilst we have the choice that's not an issue, but in 2012 they're going to start turning off the analogue transmitters. Whilst not a major problem with battery powered radios, it's a noticeable problem with wind-up radios.
- ***Ghetto blasters*** (cell battery powered) – Why? Heavy, noisy and not at all efficient given the alternatives mentioned above.

Renewable micro-power systems

Simple renewable micro-power systems don't seem to be easy to find, and in most cases you'll have to put your own together. The reason is that very small systems are not of practical use in the 'modern' home, and so are not developed for the home market. At the same time the camping market tends to focus on bulky gadgets for site campers, and so you don't get very simple and elegant mobile systems.

Most domestic renewable installations, wind or solar, usually have a generating capacity rated a kilo-Watt or more. For a small camp installation, especially if you want it portable, then you're usually looking at a few tens of Watts. That's more than enough to run your lanterns, a radio, and possibly a small cell battery charger – provided that you only use the power as and when needed rather than leaving it on around the clock (often the habit people get into when they're connected to the mains).

The diagram on the right shows the layout of a typical self-build



solar power system. Putting together and maintaining something like this takes a little learning and time – and certainly before taking it away on camp you should practise using it at home to iron out any gaps in your knowledge (otherwise you'll be carrying an awfully big lump of dead-weight!).

Developing a small-scale system like this may seem a lot of hassle when there are battery and wind-up alternatives more easily, and perhaps cheaply, available. That's true, but it misses the point of the exercise, and certainly one of the main points about the 'Great Outdoors' initiative; *developing something like this gives you the skills and knowledge required to run a house-sized system!* Building a system like this for your home is difficult because you might need planning permission for the PV or wind generator, and you'll certainly need Building Regulations consent for the wiring (you must get an accredited electrician, or paying the council to come and certify it for you). Building a system like this for use in a caravan, tent or wild camping trip doesn't require *any* legal approval!

The main restriction for a system such as this is that it's better suited to a static camp rather than a mobile expedition. For PV, being static is essential so that the panels can face the sun. A small wind generator needs mounting on a short pole, perhaps on a fence post, for as long as possible to catch the wind. In any case, you only need a system like this if you're using a lot of light or you need to charge cell batteries – that's the type of situation which is more likely to happen with a static camp rather than a mobile expedition.

The different elements of the power system shown on the previous page are described in the box on the right. Most home electrical hobbyists could put one together. Once you have the components all that's required is a soldering iron and some wire strippers/cutters.

Describing the precise process of putting a system like this together is beyond the scope of this briefing, but the Free Range *Salvage Server* Project are working on this kind of guide as part of their forthcoming *SSP Power Systems Toolkit*. This will be available during 2009 from their web site – http://www.fraw.org.uk/ssp/. Alongside this a day-long workshop, "*PV, Batteries and Bulbs – A Beginner's Guide to Renewable Power*" is also being developed which shows you how to build this system, and how to scale/modify it for different purposes.

System Components

- ***Battery*** – The core of the system, this buffers the power supply between the generator and the devices that are using it. The bigger the capacity the more power you can store, but the greater the weight. The cheapest and simplest is still seal lead-acid, or better still 'deep cycle' lead-acid batteries. Seven to eighteen Amp-hours capacity, weighing around three to seven kilos, should be sufficient to run lights and a radio at a static camp.
- ***Wiring*** – Low voltage DC wiring is ideal to carry the load. In most cases three Amp dual core (red and black or brown and blue) should be sufficient as if you use any more power you'll run the battery flat very quickly.
- ***PV*** (photovoltaic panel) – Small light weight panels, such as flexible plastic panels, would be the best option. Silicon and other panels will work the same, but they're heavier. You don't need a lot – depending on how many lights you have plugged in fifteen to thirty Watts should be enough.
- ***Wind charger*** (not shown) – Rather than the large, heavy boat wind chargers you need a small home made or science demonstration model producing only an Amp or two. When using a wind turbine you'll need a shunt regulator not a charge controller (or the turbine will run away with itself when the battery disconnects). You'll probably have to make this yourself as small capacity shunt regulator are hard to find (they're made for much bigger turbines).
- ***Charge controller*** – This monitors the battery voltage and disconnects the panels to stop the battery overcharging. You could make your own, but small charge controllers are easy and cheap to buy as you'll only need one with a capacity of a few Amps/30 to 40 Watts at most.
- ***Fuses*** – ***ESSENTIAL***. If you short the battery the surge current will melt the wiring, or quite possibly set fire to it. Automotive fuses are often used in renewable energy systems but for this job they're too big. For this reason you'll need to get some in-line 20mm cartridge fuse holders, and a selection of fuses from ¼ Amp to 2½ Amps (ideally each device has it's own fuse set for it's specific current use).
- ***Junction block*** – A standard junction/terminal block rated at five to fifteen Amps. This is just a neat and convenient way of connecting the wires together (and easily disconnecting again) without wastefully using lots of PVC tape.
- ***Fluorescent lantern/radio*** – A standard wind-up LED/fluorescent lantern, or wind-up radio (because they're more power efficient) with an external DC socket is the best option. If it runs at twelve volts that's ideal – if not you'll need to use a voltage regulator (see below).
- ***Voltage regulator*** – A small device that steps down from the battery voltage to whatever's required. You'll probably have to get a voltage regulator to run a radio as most use 4.5, 6 or 9 volts. You can get voltage regulators for use in cars, but these are usually integrated into a plug that fits into the cigarette lighter. It's far cheaper, and easier (than trying to reconfigure a car adapter), to make you own.
- ***Cell battery charger*** – These charge cell batteries from a 12 or 24 volt battery. You'll probably find one designed to fit into a car's cigarette lighter, in which case you'll need to strip off the connector (making sure you get the positive/negative leads identified first using a multimeter in 'continuity test' mode) and wire into the junction block.

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