Am I seeing an energy gain?

It seems ideas around what constitutes evidence of an energy gain are various and depend on the goals set by individual researchers and experimenters. Some set out to produce enough external power, over and above what is need to run the circuit, to be able to drive some external device such as lights or a motor for mechanical work.

For myself, the main objective is to show clear and repeatable evidence of an energy gain, whatever the source of that energy. Having significant spare energy to drive some external device is an additional bonus but not my primary objective. Having said that, it is understandable why the ability to drive some external load, however small, is seen as the only clear evidence that an energy gain is occurring whereas in fact that is not quite the case.

So before I elaborate on this, let me make a key statement that I will then go on to expand upon.

"If you are running your circuit, with some form of automatic or manual battery swapping, and your net battery voltages are remaining the same, or dropping only a small amount, then you are already demonstrating an energy gain".

In other words, if when swapping the batteries over when just running the circuit, and with no external load attached, the batteries remain at close to the same voltages, then energy must be entering the system for that to happen and you have a degree of energy influx occurring.

In practice you may find that one battery will be down a little and the other raised a little, depending on whereabouts on the cycle you turned off the device. If you measure the voltage change for each battery after stabilisation and add them together, you will have the overall nett value and find that it is zero or down by only a small fraction of a volt. What constitutes an 'ok' voltage drop will be clarified further down with a numerical example.

You have no need to do this particular test but this is what I did in the report entitled 'Interim Report 2 (Using capacitors)' in the Appendices. In this the pulses were generated in the normal way but instead of being directed to a receiving battery, they were diverted to a bank of capacitors which absorbed them and quickly raised the capacitor voltage.

For this I used the bank of four 15mF@80V low ESR capacitors designed for use with the 'cap dump' circuit used in earlier tests. These were wired in parallel to give a total effective and measured capacitance of 53mF@80V. These were charged up in less than 10s and then discharged to allow the energy stored in them to be calculated.

In so doing the CoP came in at between 0.4 and 0.5, in other words there was no observable energy gain and indicating that the electrochemistry is an important part of the process. What it's actual role is has yet to be explored but the CoP figure arrived at is pretty much the standard efficiency for the device in converting battery energy into inductively generated pulse energy. So with the HV pulses entering a capacitor instead of a battery, then you get low readings consistent with the normal losses in a circuit. An efficiency of 50% is normal for a device of this type.

So don't be disheartened as in fact your circuit may well be already showing an energy gain but just not enough to run an external load as well. To state this again - just running the circuit itself, with the batteries keeping approximately the same voltages, and by implication the same energy state, shows an energy gain since regular circuit losses should take the batteries down over time.

You would probably need to be swapping them for perhaps as long as a day or so to clearly demonstrate that - hence the use of a battery swapper circuit to automate the process. If you don't have one of those, I have put up a stand alone circuit for one in the Appendices and which is the one integrated into my v4 PCB. I may in the future design a small stand alone PCB for such a swapper if there are enough interested parties.

Now let me run through some figures to illustrate the issue.

I am basing this calculation on using a typical small SLA battery of 7Ah capacity, and assuming a typical total current draw on the supply battery of 1A to run the circuit. You can adapt the figures to suit your system but the calculation method should be clear whatever your values.

Let us say we run our device for 2 hours with the battery swapper operating and switching the battery every 10mins, whether that is done automatically or manually.

Over the 2 hours, the total run time for each battery acting as a supply is 1 hr, whatever the swap interval. This means that each battery is delivering 1Ah (1A x 1hr) of charge to the device in its role as the supply.

From discharge measurements I have done, where I have discharged 20% of the battery's 7Ah capacity, (1.4Ah) using the computerised battery analyser, the battery voltage has dropped from 12.8 to 12.4V after stabilisation, so 0.4V. This value then I would consider typical for the voltage drop when about 1.5Ah of the battery's capacity is discharged.

Therefore, in our example, where we are discharging 1Ah, we can expect to see the battery voltage drop by about a little under 0.3V (assuming everything is linear).

Given this figure of a 0.3V voltage drop after discharging 1Ah of capacity from each battery, then if you see your battery voltage remain about the same, or dropped by only 0.1V (after giving them time to recover and bounce back after being in discharge), then that is an indication that during the charging stages of the run, the batteries were receiving some energy to offset the amount lost in discharge.

Now while this is a crude calculation, it does give a quick indication that something is happening overall to prevent the battery voltage falling at a 'normal' rate for discharge given what it is supplying to the device.

In other words, seeing your batteries maintain their nett voltages (see above on finding the nett value) or, for example, drop only 0.1V with the duration and current used in my example, is already an indication that the system is demonstrating an energy gain by virtue of the fact that the batteries are not running down as fast as they should be for the energy they are supplying to the device.

This should be reason enough to be positive and optimistic about what you have built and it's inner workings, even if you are not seeing sufficient energy gain for the battery to increase its voltage overall and therefore supply an additional external load. That requires a good degree of optimisation and accurate measurements using a developed methodology.

My reason for offering this information should be clear in that it is easy to become disheartened when, after all your efforts, one seems unable to operate an even modest external load or even with no load, your voltages still drop a little.

If you adapt the calculation I have done for your setup, you may well find that you are already experiencing an energy gain but that it is 'hidden' within the workings and normal losses of your device.

Remember, the typical efficiency of a device like this is probably in the 40 - 50% range since converting the battery energy to the energy being expressed as HV spikes is not that efficient. There are various losses such as the usual resistive losses in components but also in the rise and fall of the magnetic fields in the coils arising from hysteresis and such. So a CoP reading > 0.8 is a good sign that you are drawing in some energy to offset that expended.

So maintaining your battery voltages, or incurring a small nett drop, significantly less than expected as shown above, and in the context of a typical efficiency of 50%, is good 'anecdotal' evidence that something interesting is going on.

What exactly, is another matter! :)

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