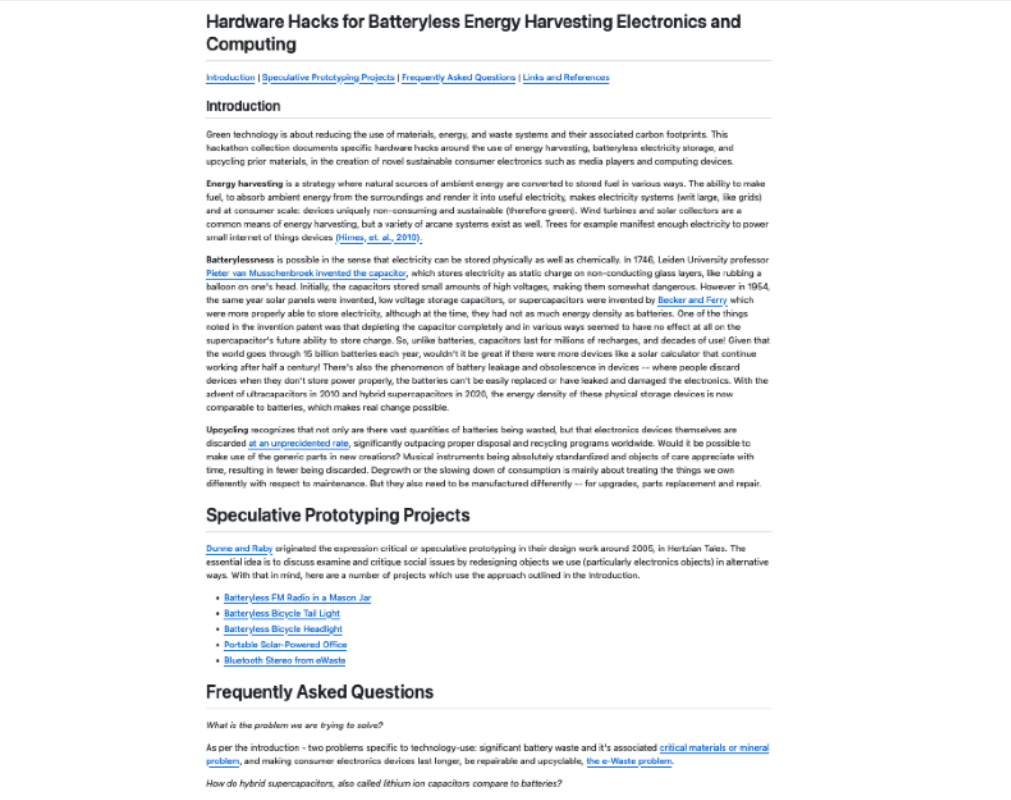
Hardware Hacks for Batteryless Energy Harvesting Electronics and Computing

Toronto Supercapacitors Group (Brian, Dublin Local Hub)

Presentation : 5 slides, 5 minutes!

- What
  - "Hardware Hacks for Batteryless Energy Harvesting Electronics and Computing"
  - DIY Electronics Documentation
- Why
  - Reduce use of batteries and need for critical minerals
  - Reduce eWaste
- How
  - Great back and forth around clarification of questions
- Who
  - Toronto Supercapacitors Grp
- Where next?
  - Complete the DIY build instructions
  - Feedback mechanism from users



Hardware Hacks for Batteryless Energy Harvesting Electronics and Computing

Introduction | Speculative Prototyping Projects | Frequently Asked Questions | Links and References

Introduction

Green technology is about reducing the use of materials, energy, and waste systems and their associated carbon footprints. This hackathon collection documents specific hardware hacks around the use of energy harvesting, batteryless electricity storage, and upcycling prior materials, in the creation of novel sustainable consumer electronics such as media players and computing devices.

Energy harvesting is a strategy where natural sources of ambient energy are converted to stored fuel in various ways. The ability to make fuel, to absorb ambient energy from the surroundings and render it into useful electricity, makes electricity systems (writ large, like grids) and at consumer scale: devices uniquely non-consuming and sustainable (therefore green). Wind turbines and solar collectors are a common means of energy harvesting, but a variety of arcane systems exist as well. Trees for example manifest enough electricity to power small internet of things devices (Himes, et. al., 2010).

Batterylessness is possible in the sense that electricity can be stored physically as well as chemically. In 1746, Leiden University professor Pieter van Musschenbroek invented the capacitor, which stores electricity as static charge on non-conducting glass layers, like rubbing a balloon on one's head. Initially, the capacitors stored small amounts of high voltages, making them somewhat dangerous. However in 1954, the same year solar panels were invented, low voltage storage capacitors, or supercapacitors were invented by Becker and Ferry which were more properly able to store electricity, although at the time, they had not as much energy density as batteries. One of the things noted in the invention patent was that depleting the capacitor completely and in various ways seemed to have no effect at all on the supercapacitor's future ability to store charge. So, unlike batteries, capacitors last for millions of recharges, and decades of use! Given that the world goes through 15 billion batteries each year, wouldn't it be great if there were more devices like a solar calculator that continue working after half a century! There's also the phenomenon of battery leakage and obsolescence in devices -- where people discard devices when they don't store power properly, the batteries can't be easily replaced or have leaked and damaged the electronics. With the advent of ultracapacitors in 2010 and hybrid supercapacitors in 2020, the energy density of these physical storage devices is now comparable to batteries, which makes real change possible.

Upcycling recognizes that not only are there vast quantities of batteries being wasted, but that electronics devices themselves are discarded at an unprecidented rate, significantly outpacing proper disposal and recycling programs worldwide. Would it be possible to make use of the generic parts in new creations? Musical instruments being absolutely standardized and objects of care appreciate with time, resulting in fewer being discarded. Degrowth or the slowing down of consumption is mainly about treating the things we own differently with respect to maintenance. But they also need to be manufactured differently -- for upgrades, parts replacement and repair.

Speculative Prototyping Projects

Dunne and Raby originated the expression critical or speculative prototyping in their design work around 2005, in Hertzian Tales. The essential idea is to discuss examine and critique social issues by redesigning objects we use (particularly electronics objects) in alternative ways. With that in mind, here are a number of projects which use the approach outlined in the introduction.

- Batteryless FM Radio in a Mason Jar
- Batteryless Bicycle Tail Light
- Batteryless Bicycle Headlight
- Portable Solar-Powered Office
- Bluetooth Stereo from eWaste

Frequently Asked Questions

What is the problem we are trying to solve?

As per the introduction - two problems specific to technology-use: significant battery waste and it's associated critical materials or mineral problem, and making consumer electronics devices last longer, be repairable and upcyclable, the e-Waste problem.

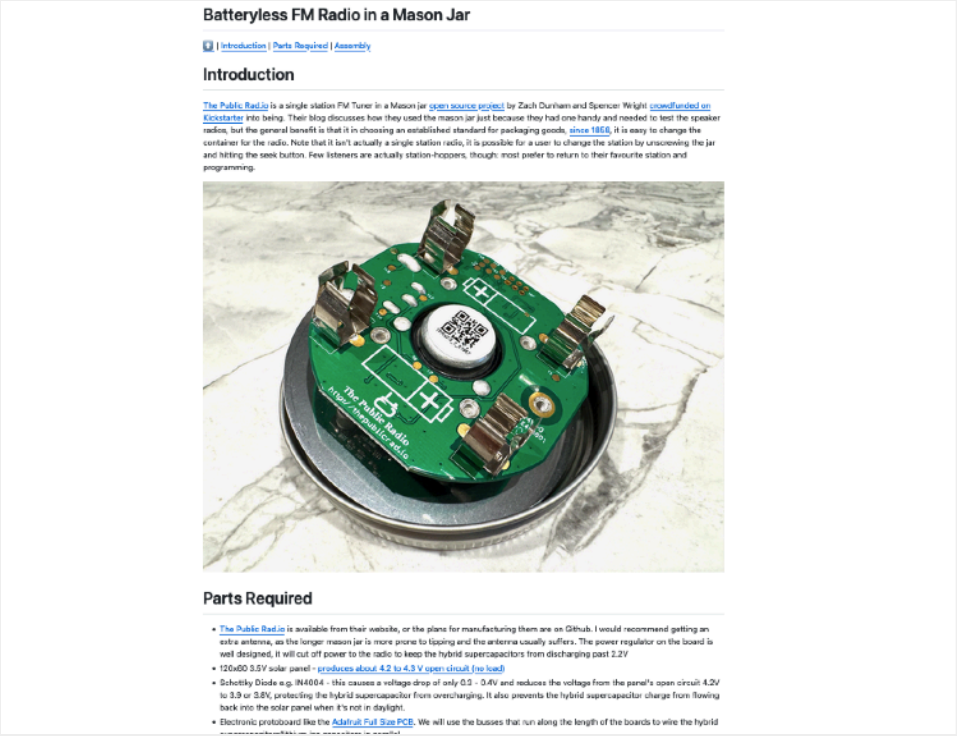
How do hybrid supercapacitors, also called lithium ion capacitors compare to batteries?

What

Hardware Hacks for Batteryless Energy Harvesting Electronics and Computing

- Instructions and visuals sufficient to build five DIY projects which feature:

- Batteryless design
- Energy harvesting mechanism
- Reuse and upcycling strategies



Batteryless FM Radio in a Mason Jar

| Introduction | Parts Required | Assembly

Introduction

The Public Radio is a single station FM Tuner in a Mason jar open source project by Zach Dunham and Spencer Wright crowdfunded on Kickstarter into being. Their blog discusses how they used the mason jar just because they had one handy and needed to test the speaker radios, but the general benefit is that it in choosing an established standard for packaging goods, since 1858, it is easy to change the container for the radio. Note that it isn't actually a single station radio, it is possible for a user to change the station by unscrewing the jar and hitting the seek button. Few listeners are actually station-hoppers, though: most prefer to return to their favourite station and programming.

Parts Required

- The Public Radio is available from their website, or the plans for manufacturing them are on Github. I would recommend getting an extra antenna, as the longer mason jar is more prone to tipping and the antenna usually suffers. The power regulator on the board is well designed, it will cut off power to the radio to keep the hybrid supercapacitors from discharging past 2.2V
- 120x60 3.5V solar panel - produces about 4.2 to 4.3 V open circuit (no load)
- Schottky Diode e.g. IN4004 - this causes a voltage drop of only 0.3 - 0.4V and reduces the voltage from the panel's open circuit 4.2V to 3.9 or 3.8V, protecting the hybrid supercapacitor from overcharging. It also prevents the hybrid supercapacitor charge from flowing back into the solar panel when it's not in daylight.
- Electronic protoboard like the Adafruit Full Size PCB. We will use the busses that run along the length of the boards to wire the hybrid

Why

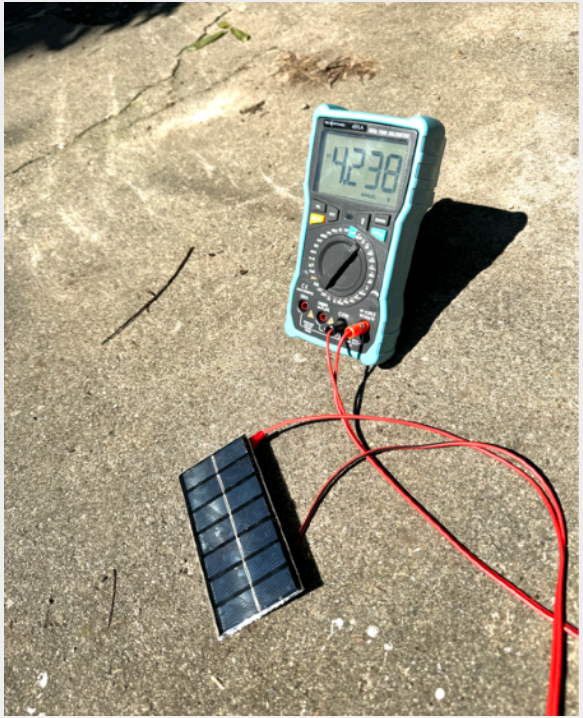
Goals

- Increase knowledge of the technology strategy in existing consumer products
- Reduce use of batteries and need for critical minerals in new products
- Reduce eWaste
- Low cost repair worthy technology!

How?

Process

- How hybrid supercapacitors adapt to consumer electronics
- DIY strategies
- Real time proofing and linking



Who

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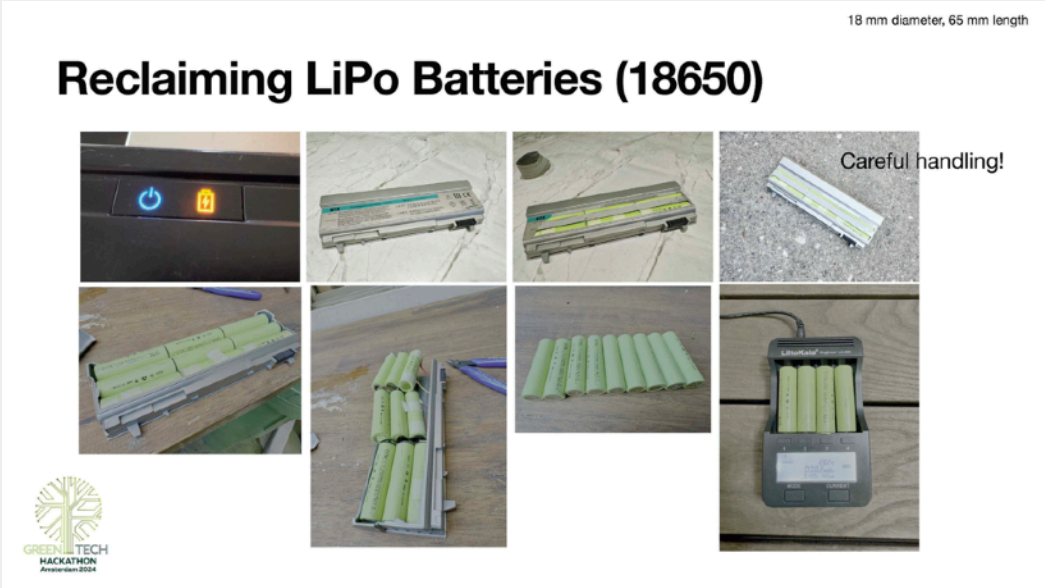
Where next?

Future Plans

- Complete speculative designs
- Add more material - circuit wiring diagrams
- Feedback from users to improve materials
- Space to host new projects of this type
- More general usability tips (such as reclaiming batteries from ewaste)



Questions?