⚡🔋☀️COMMUNITY POWER PODS PDX☀️🔋⚡

🛠️How To & Resources🛠️

This workshop will provide the basic knowledge and resources required to build a DIY "Power Pod".

💀⚡☠️CAUTION: Working with batteries and electronic circuits is potentially hazardous and could lead to injury or death if proper safety measures are not followed.💀⚡☠️

- **What is a "Power Pod"?**
  - A DIY mobile battery powered generator using second-hand and recycled lithium ion batteries, usually from electric vehicles. The pods can be charged using solar energy. Comparable commercial products are the Jackery and Bluetti portable power stations, however these are significantly more expensive than building your own.
- **How does a Power Pod work?**
  - A battery pack which stores Direct Current (DC) electricity is connected to a high powered Pure Sine Wave Inverter, which converts the stored DC power to Alternating Current (AC) at the voltage required for powering household electronics and appliances.
- **What goes into building a Power Pod?**
  - Battery
  - Pure Sine Wave Inverter
  - Fuse
  - BMS
  - Breaker (or disconnect Switch)
  - A portable case of some kind
  - Charging equipment
    - Solar charge controller + panels
    - DC power supply and a hobby charger (Q8)
  - Cabling, connectors, nuts & bolts, heat-shrink!
- **DC electricity**
  - Volts: The measurement of the electrical charge potential between two points.
  - Amps: The measurement of the rate of current at which electricity flows.
  - Resistance: The measurement of resistance to electric flow in a circuit.
  - Watts: **Volts x Amps = Watts.** The measurement of total electrical power being generated.
- **Explanation of parts**
  - Battery
    - Common Types:
      - Lithium Ion (NMC): Typical in consumer devices, high energy low weight.
      - Lithium Iron Phosphate (LiFePO4/LFP) : Long life span, less dangerous than NMC lithium batteries.
      - Lead Acid: Typical for car and automotive batteries. They suck.

        - Battery Cells: individual modules that make up a larger battery.
            - Acceptable voltage ranges per cell differ depending on chemistry:
                - Lithium Ion (NMC): 2.8v - 4.2v
                - LiFePO4: 2.5v - 3.65v
            - At the high voltage a cell is fully charged, at the low voltage it is fully discharged, meaning it cannot safely output any more power.
            - Cell Balance: For best performance of a battery the voltage of all cells needs to be close to the same, so that each cell is providing the same amount of power and there is no risk of overcharging or over-discharging any individual cell.
            - Series vs Parallel connection of cells:
                - Series: Adds voltages of cells together to attain a higher voltage for the battery. Connect positive to negative in a string.
                - Parallel: Adds amp capacity of cells together by distributing current between them. Connect positive to positive, and negative to negative.
                - Series and parallel configuration of cells in a battery is specified as “s” and “p”. Ex: 4s2p
        - Battery capacity
            - Watt-Hours (Wh): Measurement of how many watts a battery can run for 1 hour from full charge to depletion. Ex: A 100Wh battery can output 100 watts for 1 hour continuously.
            - Amp-Hours (Ah): Measurement of how many amps a battery can output for 1 hour.
            - C Rate: Measurement of how much power a battery can safely output. 1C is the power that will deplete a battery in one hour, so for example: a 2000Wh battery that is rated at “1C” can be discharged at 2000 watts safely. If it were “2C”, it could output 4000 watts, etc.
        - Battery form-factors:
            - Pouch (LiPo NMC): High energy density, low weight and smaller size. Easier to puncture, so more dangerous.
            - Prismatic: Contained in a solid metal enclosure, heavier and bigger than pouch but more robust.
            - Cylindrical: Contained in small cylinders, such as AA batteries.
    - BMS: Battery Management System
        - BMS monitors battery cells, making sure their voltages stay in sync.
        - Protects against short circuit, overcharge, overdischarge, and low or high temperatures.
    - Inverter (DC to AC converter)
        - Pure Sine Wave: Outputs a smooth sine wave of alternating current, some sensitive equipment requires this.
        - Simulated Sine: Outputs a rough approximation of a sine wave, can damage some devices or create a buzzing sound.
        - Watt ratings of inverters:

            - Max continuous output: Maximum wattage that can be run by the inverter for a long period.
            - Peak output: Maximum wattage that can be run for a short period, usually a few seconds or less.
        - High and low voltage cutoffs: The maximum and minimum voltages an inverter can use from a battery. Select an inverter that has a voltage range that matches your batteries, or is close enough.
- **Fuses/Breaker**
    - Safety devices that will disconnect the power if there is too much electric current, which causes wires to heat up or can damage components.
- **Cabling**
    - Wire gauges (AWG), thicker wires for higher amperage. Err on the side of thicker cabling when able.
        - Copper cables vs. copper clad aluminum :
            - Pure copper cabling is higher quality, and will not heat up as quickly when there are high amps running through a wire.
- **Wire connectors**
    - XT60, lugs, anderson power pulls, MC4, JST
- **Solar equipment**
    - Solar Charge Controller
        - PWM (pulse width modulation) and MPPT (maximum power point tracking)
            - PWM: Cheaper, less efficient. Does not allow for high voltage solar input-- pulls solar panel voltage down to match battery.
            - MPPT: Tracking algorithm to find the maximum amount of power it can pull from the solar panels. Allows for high voltage solar input, which it converts to the lower voltage to match the battery.
        - Amp rating: maximum amps a controller can output.
        - Maximum and minimum solar panel voltages
        - Lithium ion setting (IMPORTANT): needed to work with Lithium batteries. Most solar charge controllers are STILL designed for lead acid batteries.
    - Solar panels
        - Types: Polycrystalline, Monocrystalline, Amorphous Silicon (flexible)
        - Multiple panels can be configured in series or parallel for different voltage or amperage combinations depending on needs.
        - Solar cells (configured in series) -- blocking light on one cell will affect the whole panel's power output, so full sun is needed.
        - Maximum power output of the panel is rated in watts. Panels will only output maximum power under "ideal" light conditions.
        - Panel voltage & specs
            - Open Circuit Voltage (Voc)
            - Voltage at max power (Pmax)
            - Short circuit current (Imp)
            - Current at max power (Imp)

- **Where to buy:**
  - Batteries
    - Batteryhookup.com
    - Batteryclearinghouse.com
    - Bigbattery.com
    - Techdirectclub.com
  - Inverters / BMS
    - Ebay, AliExpress
  - Solar Charge Controllers
    - Ebay, AliExpress
  - Solar panels
    - Ebay, Facebook Marketplace, Craigslist
    - Recycledgoods.com
  - Battery Chargers & Power Supplies
    - Ebay, AliExpress
    - Recycledgoods.com
- **What can you power/charge?**
  - Use a “Kill-a-watt” Meter to figure out the wattage draw of a device.
  - Divide battery watt-hours by device wattage for approximate hours of runtime.
- **Safety & Dangers ☣️🈲💀⚡☠️🔥☢️:**
  - Short circuits: When there is a direct connection between positive and negative battery terminals. This will cause extremely high electric current to flow, which can damage the batteries or equipment. Can create sparks, start fires, or cause burns or electric shock if you are in direct contact with the electricity.
  - Charge settings for battery 🔥**DO NOT OVERCHARGE OR OVERDISCHARGE**🔥
    - Depends on the number of battery cells in series and the battery chemistry. Ex: A lithium Ion battery can be charged to 4.2v per cell. So, a battery with 3 cells in series can have a maximum charge of 12.6v (4.2v x 3). Set the charger settings to match this.
  - Extinguishing battery fires (in rare event that this happens):
    - Do not pour water!
    - Table salt to smother flame
  - Do not puncture battery cells!
- **Resources**
  - Batteryuniversity.com
  - Youtube:
    - DIY Solar with Will Prowse
    - Jehu Garcia
    - David Poz
    - altE Store
  - Forums:
    - DIY Battery (Facebook group)
    - DIY Solar Power Forum