Have you ever wanted the ability to power virtually anything on the go?
Well, In this video I will show you step by step, how you can make a power bank that can do just that.
The power bank's main features are the ability to power at least 7 devices at once, and having a removable battery pack that consists of 15 18650 batteries which can be replaced for extra capacity.
Furthermore, 18650 batteries are easily found in things like old laptop batteries, So it is easy to get them for free or very cheap. And if you manage to do that, the total cost of the components goes down to $60 which is two times cheaper than anything commercially close.
For output, It has a 150W wall port that can power everything from Lights and Fans to Mini Fridge or even TVs.
It also has a DC port that is adjustable From 13 to 50 volts That is made for devices that can accept DC directly like laptops and some soldering irons. With a maximum power output of 120 watts, The power bank can power mid-range gaming laptops comfortably even at maximum load.
Finally, the power bank also features 4 standard USB ports with two having Quick Charge 3.0.
Also, it has a wireless charging pad on top for when you forget the cable.
The power bank Chargers with either a standard laptop charger or USB C. Depending on the charging current you said the power bank can be charged in under 5 hours.
And optionally, This power bank also features RGB for extra coolness Factor.
All this power comes in a size slightly larger than a standard water bottle so It can be easily carried around.
Furthermore, with overvoltage, over discharge, short Circuit and over temperature shutdown. Along with a fully automatic cooling system, the power bank is very safe to use if built correctly.

With all the features out of the way, I will now show you step-by-step how to build this power bank.
Here are the timestamps for the video, you can skip to any of those steps if you want.
But for the rest of you, here we go.

For this project, you will need a number of different components. As for always all the links and files are in the description.

For the output, you will need a 12-volt to USB Quick Charge car adapter.
I have already taken out of its case.
A 200-watt boost converter.

A 150 watt 12-volt inverter with two USB ports.
And finally a wireless charging coil.
To charge the batteries you are going to need a step-down converter with a constant current feature.
Two more mini DC step down converters.
A 3s lithium-ion battery management circuit, With balance charging. The board also has overcurrent, over discharge, and short circuit protection.
To switch the high currents, you will need this SRA 12-volt DC relays that can handle up to 20 amps.
Two female 5mm DC Jacks.
60x10 mm 12 volt fan to cool the circuits.
A Schottky diode that can handle at least 5 amps.
A pair of xt60 connectors.
A 20 amp car fuse.
7x3 amp slide switches.
If you want RGB on your power bank, you will need 12-volt RGB strips and a three-button controller.
You will also need 22, 18, and 12 gauge wires.
Two mini voltmeters.
You will also need 0.5 mm thick copper strips for busbar.
M3 flathead screw
5mm Aluminum heatsinks
Various color 3mm LEDs
The temperature control and protection are done through the bimetal temperature switches.
These switches open or close at their rated temperature.
You will need 4 normally open 45 degrees type, and 3 normally closed 45 degrees.
Most importantly, you will need 15 18650 batteries. You can use new or old cells as long as they satisfy these three conditions.

1. They have the same tested capacity
2. They have roughly the same internal resistance.
3. The maximum discharge current of each cell must be at least 5Amps

I bought my batteries with tabs so I don't have to solder directly to the batteries.
Finally, you will need to 3D print all the files in the description, be aware that some components must be printed in PETG or ABS so they don't melt.

Here is the overall schematic of the power bank, it is separated into 7 parts, they are the battery pack, the charging circuit, the AC interval, the DC step-up converter, the

USB and over temp protection circuit, wireless charging circuit, and finally the automatic cooling system with RGB.

I also included the full assembly power bank, If you wonder how the power bank comes together, you can download the model and see for yourself.
I also included the version without USB C, and the version without RGB.

The first step to building this power bank is making the removable battery pack.
To start, get the tested 15 18650 batteries. I'm using the model NCR 18650B its high capacity, it is even used in early Tesla cars. but if you want to bring this on a plane, use cells that are less than 1800mAh or use fewer cells in each parallel group.
Measure each cell to make sure that they are at around the same voltage. If not, charge or discharge cells until all 15 cells have the same voltage.
Now get the 3D printed battery holder, and insert the battery with the anode facing up on the sides and cathode facing up in the middle
This creates a configuration like this.
This is what the batteries look like from the front.
After the batteries are inserted, press on the cap and secure with 6 screws.
Before the front two screws are secured, slide in the BMS like this.

Now cut 4 strips of 0.5mm thick copper sheet that is 7mm wide. This is what's going to carry the large current from the batteries. You can also use brass or nickel strips if you have them.
Bend and cut the copper strips to length.
Now get your iron as hot as possible, and tin the copper strip.
Now solder the batteries to the copper strip, make sure you never spend more than 3 seconds per solder connection, and only re-solder after the joint cools down.
When the soldering is done, the battery pack should look something like this.
Now check each strip to make sure that they have the correct potential.
Then the strips can be soldered to the BMS.
Next, solder short wires to an XT60 male connector
And place and solder the XT 60 in the holder of the battery pack.
Then, glue the xt60 in place, make sure that it is straight and flush with the surface.
Optionally, you can add heatsink on the MOSFETs.
Now it is time to test the battery pack to make sure it is safe to use.
First, add a heatsink onto the converter, then connect the input to a power supply that is above 14 volts.
Then, connect the output to a volt and amp meter.
Adjust the output to 12.6 volts.

Next, short the output so the converter inters current display mode.
And adjust the output to anywhere between 2-3.5 amps, depending on how fast you like your battery to get charged, and the capabilities of your power supply.
Then, connect the output to the battery pack, the battery pack should begin charging as the blue light turns on.
Closely monitor the voltage and temperature of each cell, If there is a deviation of 0.2 volts or a cell gets notably hotter than other cells, stop the charging process immediately, and check the solder connection or replace the cell.
When the light turns green, the charging process is finished.
The second test is the discharge test,
First, connect the battery to the input of the ammeter.
Then, get something that uses 12 volts and draws a lot of power, in this case, I'm using my 100W flashlight, I made a video about how to make this flashlight, check it out if you are interested.
Anyway, put at least a 10 Amp load on to the battery pack for 20 minutes. During this time, closely monitor the voltage and temperature of the pack, pay special attention to the solder joints, as improper joints can heat up quite a lot.
After repeating these two tests 2 more times, we can move on to making the locking mechanism.
First, get the 3D printed parts, and a hinge.
Using the hinge, mount the pull tab to the base. The hinges in the video are too small, so, later on, I switched to a larger hinge.
Then screw in the locking ring, and add in the locking shims.
Finally, add on the lid and screw the assembly on to the back of the battery pack.
The battery pack is now complete, it can be used as a normal 12-volt battery, here it is powering my light.
You can make as many of these packs as you want as long as you have enough batteries, this way if 188Wh is just not enough, you can just slide in another pack.

The Next step is to make the charging circuit, here is the overall schematic.
This is how it works; when no power is connected, the current flow through the normally closed contact of the relays and to the output.
When power is connected, current flow through the step-down converter with constant current but is then stopped at the relay. At the same time, current flows through the mini step down converter. This turns on the cooling fan and the two relays. Now the current from the step-down converter with constant current can flow into the batteries.
Now the output is switched off, this way the batteries are protected from being charged and discharged at the same time.
Now we need to make some additional modifications to the step-down converter.

First, desolder the screw terminals and the LEDs.
Then add a Schottky diode facing into the input.
Next, solder thin wires to the LED pads.
Now get the 3D printed base, and attach the step-down converter to it.
Then solder the input of the step-down converter to 5mm DC jack.
If you want to charge the power bank with USB C, then you will need to buy a small USB C 20V trigger, and solder it in parallel with the DC Jack.
Next step is to solder 3mm red, green, and blue LEDs to the wires, and test them to see if they still work.
Then, mount them on to the side in the order from top to bottom of green, blue, then red.
Next step is to get the mini step down converter and adjust its output voltage to 12 volts.
And then solder it to the DC jack.
Now place 2 relays in this orientation.
Oh and I almost forgot to solder the 45 degrees normally closed temperature switch in series with the input. This switch extends into the battery compartment. This way if the battery gets too hot, the circuit automatically stops the charging process.
Next, solder the two relay coils in series with the output of the mini step-down converter.
Then solder a thick 12 gauge wire 90 degrees to a XT60 female connector. Then solder on a 20Amp automotive fuse. And wrap the contacts to protect it.
Then, solder a 12 gauge wire to the negative terminal.
Next, attach the XT60 connector to its holder on the base.
Solder the positive wire to both common contacts of the relay.
Then glue the XT 60 connector in place.
cut and tin the ground wire.
Finally, Solder the output of the step-down converter to the normally open contact of the relays.
Side on the battery pack, connect it to power. The blue LED indicates that the battery is charging,

Awesome. Now we can move on to the Inverter circuit.
First, take the inverter circuit out of its case, and keep the screws because we will need it for the last step.
Disconnect the 30mm fan and outlet.
Glue and solder the fan to the slot next to the mini step down converter.
If you remember the last power bank I made, you would remember that the inverter has heat sinks on the power MOSFETs.

However, this inverter does not have heat sinks, so we need to make our own.
I simply bent two pieces of copper sheets and thermal epoxyed them onto the small heat sinks. And then thermal epoxyed them onto the MOSFETs.
On one of them, I attached a 45 degree normally open thermal switch. Also, wrap all thermal switches in tape because they are not isolated.
Here is what the finished assembly looks like.
Before adding in the inverter, slide a relay into the base.
Then solder a 12 gauge wire across three relays like this.
Carefully slide in the inverter.
Solder the positive input of the inverter to the normally open pin of the relay.
Then solder the ground wire to the ground wire of the XT60.
Solder a switch to one of the coils pins of the relay, and solder the other coil pin to the ground.
With this, the base is finished. Now we can move on the middle layer.

First, unscrew the boost converter and take it out of its case.
Then, desolder the screw terminals, the potentiometer, and the LED.
Replace the small SMD LED with a 3mm one.
And use longer wires to extend the potentiometer.
Solder a18 gauge wires to the output.
Then slide in the boost converter onto the 3D printed middle layer and screw it in to secure it.
Slide the potentiometer in this orientation into the middle layer.
Then get the 3D printed voltmeter and switch bracket.
Add in a voltmeter and a switch and solder them in series.
Test the voltmeter to make sure it is accurate.
Now solder and glue a DC jack onto the output of the boost converter.
Glue on the voltmeter and switch and solder it in parallel with the output of the boost converter.
Then, press a relay in this orientation.
Solder the normally open pin to the input of the boost converter.
Then, solder a switch to one of the coil pins.
Then get the 3D printed adjustment knob, and insert a piece of 0.5mm copper sheet into it.
Glue the stopper on to the other side and make sure the knob spins freely.
Carefully line up and glue the adjustment knob on to the middle layer.
Now as the knob is turned, the potentiometer turns with it, and the voltage can be adjusted this way.

Next, desolder the LEDs on the USB Quick charge converter, and replace it with a 3mm green LED.
Then, desolder the contacts on the board.
Cover the contacts on the back with Kapton tape. Then thermal epoxy on small heat sinks, along with a normally open 45-degree thermal switch.
Ok, I have to stop the video right here, because I forgot to film a step.
That is to solder two wires to the positive and ground pin on the USB, this is for the wireless charging circuit.
Then, press and glue the USB assembly onto the board.
Next, thermal epoxy another normally open 45-degree thermal switch onto the heatsink of the boost converter.
Then, solder the two thermal switches in parallel.
Solder the ground of the USB converter to the ground of the boost converter.
Then, add a switch on top of the switch for the boost converter.
Solder one switch wire to the positive of the USB converter, and the other wire to the other coil pin of the relay.
By the end, you should have, a pair of wire from the USB output, a pair of wire from the two thermal switches in parallel, and another pair of ground wires.
Finally, insert a 45 degree normally closed thermal switch to the bottom of the assembly.
Before adding on the middle layer, thermal epoxy a 45 degree normally open thermal switch next to the inverter relay.
And solder the two two temperature switches in parallel.

Alright, time to put the two layers together, carefully place on the middle assembly.
Solder 12 gauge output wire to the input of the relay.
And then attach both ground wires to the ground wire of the XT60.

Next step is the automatic cooling system.
For this step, locate the 2 pairs of wires from the temperature switches.
Solder one side of the parallel connection directly to the input of the relays. In other words, they are connected directly to the battery so the cooling system would be always active.
Now, get the 60x10mm fan and optionally, another mini DC step-down converter. This is to adjust the fan speed since the 12v fan I have is too fast and noisy. So I used this converter to step down the voltage to 8V. Skip on this if desired.
For my case, I soldered the output of the boost converter to the fan.
And then the other pair of parallel wires from the temperature switches.
And connect the step down converter to the ground wire.

This is the overall circuit of the cooling system, all switches are wired in parallel. This way if any of the switch scene a temperature of 45 degrees, the fan would turn on.

The next circuit is the relay power system and USB converter circuit.
This is the overall schematic. Basically, the current from the battery passes through the then output, then through two 45 degree normally closed thermal switch.
Then the current can flow to three components in parallel, they are the inverter relay, the boost converter relay, and the the USB converter. This is also the over temperature protection system, as if either of the thermal switches detects a temperature of above 45 degrees, no relays can be turned on so the power bank output shuts off.
First, solder the 45 degree normally closed thermal switch to the 12 gauge wire from the output.
Then, solder the switch in series with the other normally closed temperature switch which was mounted under the middle layer earlier on in the video.
Next, solder the output of that thermal switch in parallel with the USB converter switch, and the two relay coil pins that havent been used.

Now it is important to test the circuits to make sure all systems are working properly.
Connect 12v power to the XT60 connector and flip on all the switches.
As you can see, all the output circuits turns on.
Now let's test the over temperature protection circuit.
First, I set the temperature of my soldering iron to 100 degrees, then pressed on to the normally closed thermal switch.
As you can see, after a few seconds, all the output turns off, and only turns on after the switch has cooled down.
Now I load each circuit to the maximum, and wait to see if the cooling fan turns on.
With all the testing done, congratulations, you have just made it through the most complex part of the assembly.

Now screw the middle assembly on to the base with 5 screws.
They are, the three screws on the side, one screw here, and one screw here on the back.
Then glue the cooling fan on to the side.

The final step of the assembly is the top layer, which houses the voltmeter, the wireless charger, and optional the RGB circuit.
First, mount a voltmeter and switch on to the top assembly.
Then connect them in series.
Next, get the RGB controller and desolder the output connector.

Mount a small switch in this location.
Then glue the RGB controller next to it and solder it in series with the switch.
Then solder the RGB controller in parallel with voltmeter.
This is what the circuit looks like.
Next, slide in the wireless charging circuit glue it in place.
Then solder a switch in series with the wireless charging circuit's micro USB input.
Then, I added some copper heat spreaders on to the wireless charging circuit, but this is optional.
The next step is to solder the 4 control wires to the RGB controller and connect them to cut up RGB strips on to the back. You can place the strips almost anywhere on the back.
Then solder the break out pins to the last LED strip.
Then I made 4 more LED strips connected with wires in between, and mounted them in the grooves of the battery compartment.
Next we can put the top layer on to the assembly.
Solder the RGB and voltmeter system directly to the output of the batteries. This way, the circuit always remains active even when thermal protection circuit is tripped.
Then, using a large heat shrink tubing, insulate the ground wire.
Next, connect the wires from the USB output to the input of wireless charging switch.
Then, screw on the top lid with 4 screws.
Next, let's give one final test to the charging circuit by connecting the battery.
And turning on all the output components.
As soon as the charging cable is connected, all the output is turned off and the current flows to the battery.
And heating the temperature switch for the charging circuit, the charging automatically stops and only starts after the switch has cooled down.

The next step is to attach the battery compartment, you should have the two thermal switches and the RGB cable sticking out.
Connect the RGB cable and slide on the battery compartment.
And then, press the two thermal switches into the grooves.
Then, secure the battery compartment in place with 8 screws.
Slide in the battery to make sure everything lines up.

Ok, almost there, the next step is to get the 3D printed IO shield. Depending on the whether your power bank has USB C or not, you will need to print the appropriate model.
In any case, the IO shield is printed in 0.2mm nozzle with a filament swap so it has two different colors.

Fill the LED holes with hot glue so it diffuses the light.
Then, insert the AC outlet into the IO shield and glue it in place.
Next, glue the inverter switch next to the two USB ports.
Then, connect the AC port to the inverter board.
Screw in the IO shield with the screws salvaged from the inverter earlier in the video.

Next, get the 3D printed outer sleeve, I included a version with or without RGB, but you can always customize the model to have your own pattern.
Slide in the assembly into the into the outer sleeve, then secure it in place with screws on both ends.
Glue the RGB controller cover on and add on the stickers.

Finally, get the 3D printed end caps, I printed them out of Ninjaflex so it is flexible and able to absorb shock and impacts.
The caps are glued on with double sided sticky tape so It can be removed if needed.

With that, the powerbank is finally complete. Thanks for staying with me through the whole process.
With the removable battery pack, you can make as many of them as you want for infinitely expanding capacity. Comment below if you want to see a video of how to test and refurbish old 18650 batteries to they can be used to make the battery pack.
The power bank can be used for emergency backup power, for outdoor camping, or anytime you need portable power on the go.

Here is the a few guides and tips and tricks about the power bank.
It is not a good idea to alway charge the battery to full. As you can see from this graph, the less the battery is charged, the more the cycle life.
So to prolong the life of the battery, try to keep the voltage of the battery between 10-12V.
For the best practice, always plug in the device after turning on the circuits, and disconnect all load before charging.
Also, always check the voltage on the DC port before plugging in the device, otherwise you ran a risk of frying the device.
And of course, do not leave the power bank in sunlight or rain.
Also, I included all the schematic and additional information in a link in the description.

So that is it for this project. If you liked this project, please give the video a like and consider subscribing for more DIY projects like this, I'll leave you with a timelapse of the design process. And as for always, Thanks for watching.

Description:
In this video I will show you the ultimate solution to power on the go. This DIY power bank features a removable battery pack, which can be easily replaced, giving this power bank unlimited capacity as long as you have enough cells. The cost of the row components of this power bank is around 60 dollars, which is two times cheaper than anything commercially equivalent.

WARNING: Do everything at your own risk, lithium batteries can catch fire or explode if mishandled. This power bank requires a more than basic understanding of electronic to complete.

Schematics and the script:
3D print and CAD files: coming in less than 24hrs

Part links: (some are affiliate)
15x 18650 battery, if you are going to buy new, I recommend these:
https://www.alibaba.com/product-detail/20A-high-discharge-18650-2500mah-3_60842394272.html?spm=a2700.7724838.2017115.120.656b3c15t5pLHy
Or NCR18650B/BD
https://www.alibaba.com/product-detail/Original-Japan-NCR18650B-3400mAh-3-7v_60482164381.html?spm=a2700.7724838.2017115.83.178268efmg9Mey
USB 12V quick charge:
eBay:https://www.ebay.com/itm/USB-Fast-Quick-CAR-Charger-Adapter-16W-5-9-12V-3-1A-for-Android-or-iPhone/143148815849?var=442095655563
Amazon: https://amzn.to/2KbJoE5
200W boost converter:
eBay:https://www.ebay.com/itm/200W-DC-DC-Boost-Converter-6-35V-to-6-55V-10A-Step-Up-Voltage-Charger-Power/222147971321
Amazon: https://amzn.to/2KdpvfW
12V Inverter 110V:
ebay:https://www.ebay.com/itm/150W-Power-Inverter-DC-12V-to-110V-Car-AC-Adapter-with-3-1A-two-USB-ports-US/112994629611
Amazon: https://amzn.to/2Wdduyy
12V inverter 220V: Warning! can only be used on resistive load.
eBay:https://www.ebay.com/itm/DC-AC-Step-up-12V-to-110V-220V-Inverter-Boost-Board-150W-Converter-Transformer/222545838612?hash=item33d0c40214:g:BsoAAOSw6YtZQSd5
Amazon: https://amzn.to/2WfxEYv

Wireless charging circuit:
eBay:https://www.ebay.com/itm/Practical-DIY-PCBA-Circuit-Board-Coil-Wireless-Charging-Qi-Wireless-Charger-USB/283387526814?var=584364033055
Amazon: https://amzn.to/2WAC9w2
DC DC step down constant current:
eBay:https://www.ebay.com/itm/DC-Step-Down-Voltage-Constant-Current-Buck-Regulator-Battery-Charger-LED-Driver/191902394789
Amazon: https://amzn.to/2WfV93R
Mini DC step down:
eBay:https://www.ebay.com/itm/2pcs-Mini360-3A-DC-Voltage-Step-Down-Power-Converter-Buck-Module-3-3V-5V-9V-12V/382620018157
Amazon: https://amzn.to/2KipmI2
3s BMS with balance:
eBay:https://www.ebay.com/itm/3S-25A-protection-PCB-board-W-balance-BMS-for-18650-Li-ion-lithium-battery-H/153309641527
Amazon: https://amzn.to/2W9FRNU
12v 20A mini relay:
eBay:https://www.ebay.com/itm/SONGLE-10-pcs-Relay-5-Pin-SPDT-SRA-12VDC-CL-DC-12V-Coil-20A-Universal-PCB-N-K8L1/182546713277
Amazon: https://amzn.to/2Min8ev
Temperature switch (4x N.C. 45 degrees & 4x N.O. 45 degrees.)
eBay:https://www.ebay.com/itm/5pcs-40-160-C-Bimetal-Temperatur-e-Thermostat-Control-Switch-N-C-250V-5A-KSD9700/162152873403?var=461125914349
Amazon: https://amzn.to/2QwIhjt
Slide switches:
Amazon: https://amzn.to/2KaQnxe
eBay:https://www.ebay.com/itm/10PCS-4-7mm-2A-125V-SPDT-1P2T-2-Position-3-Pin-Slide-Switch-5mm-Shaft-Straight/192647303542?hash=item2cdaac9176:g:4mYAAOSwK1xbTGDZ
60x10mm fan:
Amazon: https://amzn.to/2WbIiiZ
eBay:https://www.ebay.com/itm/12V-DC-60mm-2Pin-60x60x10mm-CPU-Cooling-Computer-PC-Case-Cooler-6010-Fan-US/192490647474
USB C trigger:
https://www.ebay.com/itm/Type-C-USB-C-PD2-0-3-0-to-DC-USB-fast-charge-trigger-Poll-detector-Charging/173725301413?hash=item2872d5baa5:m:mtQk2e9KiBozm3GpMOpgZzQ
RGB controller:
https://www.ebay.com/itm/Mini-3-Key-Controller-Dimmer-Amplifier-For-RGB-3528-50

50-5630-LED-Light-Strip/182695567707?hash=item2a8981215b:m:m8fh4a4fxff7sF5FI6SpQwg
XT 60, wires, and RGB strips are salvaged from old electronics.

Music used:
There It Is by ZAYFALL https://soundcloud.com/zayfallmusic
Music promoted by Audio Library https://youtu.be/e9CtjM_2yKg

Spite by ZAYFALL https://soundcloud.com/zayfallmusic
Creative Commons — Attribution 3.0 Unported — CC BY 3.0
http://creativecommons.org/licenses/b...
Music promoted by Audio Library https://youtu.be/PLw9gIZjEbQ

Parasail - Silent Partner (No Copyright Music)
https://www.youtube.com/watch?v=MzO4zfNO0kQ

Altro - Epic [NCN Release]

https://www.youtube.com/watch?v=Ove9aWhwtA8