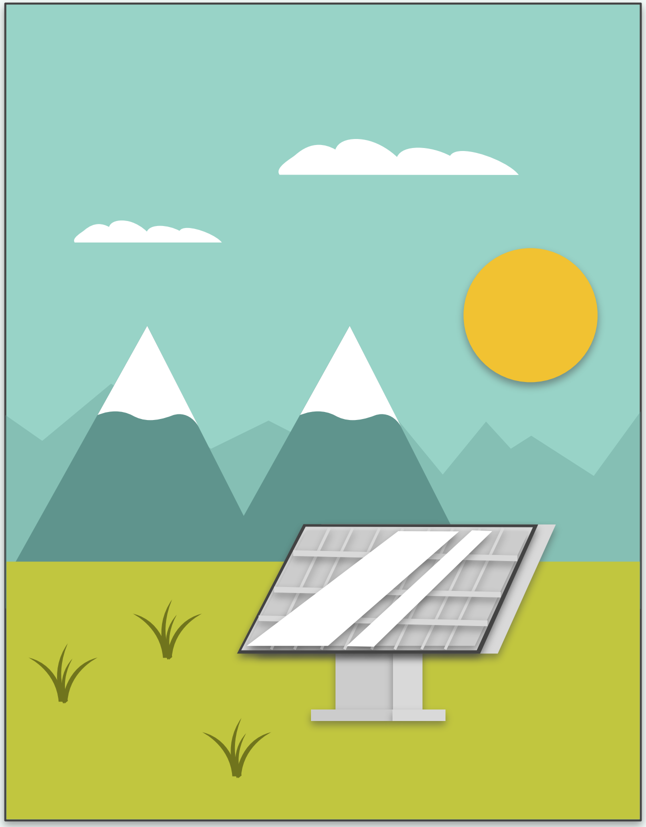
Solar Picnic Table

Senior Design Project: Group 18



Our Team

Azzan Al Busaidi
Electrical Engineering

Thach Vo
Computer Engineering

Amos Luo
Computer Engineering

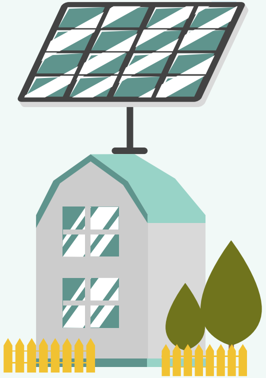
Faisal Al Ghafri
Electrical Engineering

Our Goal

To Design picnic table that steps up any outdoor adventure experience. Powered by a solar panel, our picnic table will incorporate the most essential technological features according to customers' demand.

Motivation

- **Preparing electronic gadgets for an outdoor trip is difficult**
  - Easy to forget/miss essential gadgets
  - Hard to protect from rain/dust
- **Gap in the market**
  - Most tables lack essential features
  - Market options are too expensive
- **Keeping it green**
  - All table features are powered by a solar panel



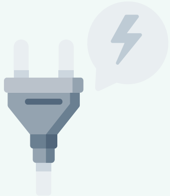
Market Options

Product	Problem
Enerfusion Aurora Solar Picnic	● Too Expensive ● No lights
Eshine Solar Table	● No shade ● No cellphone app ● Low power

Features

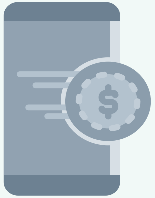
50W Panel

Motion Triggered LED Lights

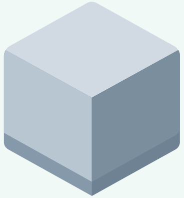


Power Outlet

Voltage & Temperature Readings



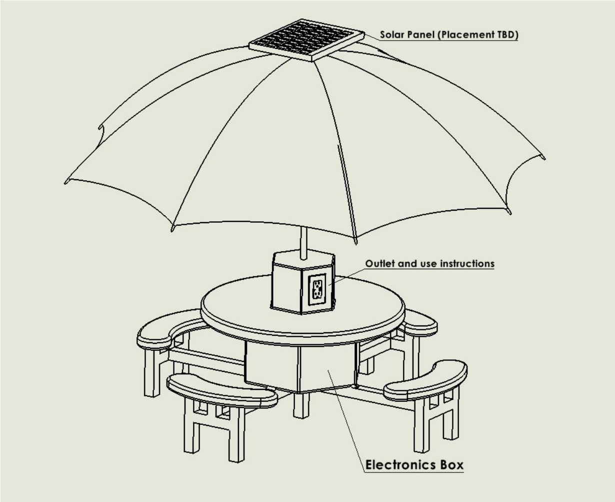
Smartphone App



WaterProof Electronics Box

What We Will Provide

- **Elevate any outdoor adventure**
  - Power your devices
  - Battery for night-time power usage
- **Provide a high-quality durable product**
  - Weather condition resistance
  - Waterproof box for vital-component protection
- **Phone application**
  - View sensors’ readings
  - Bluetooth Connection
- **Sustainable energy**
  - 50W solar panel



Stretch Goals

01

More Power

Bigger sun-tracking PV unit, and more battery capacity.

02

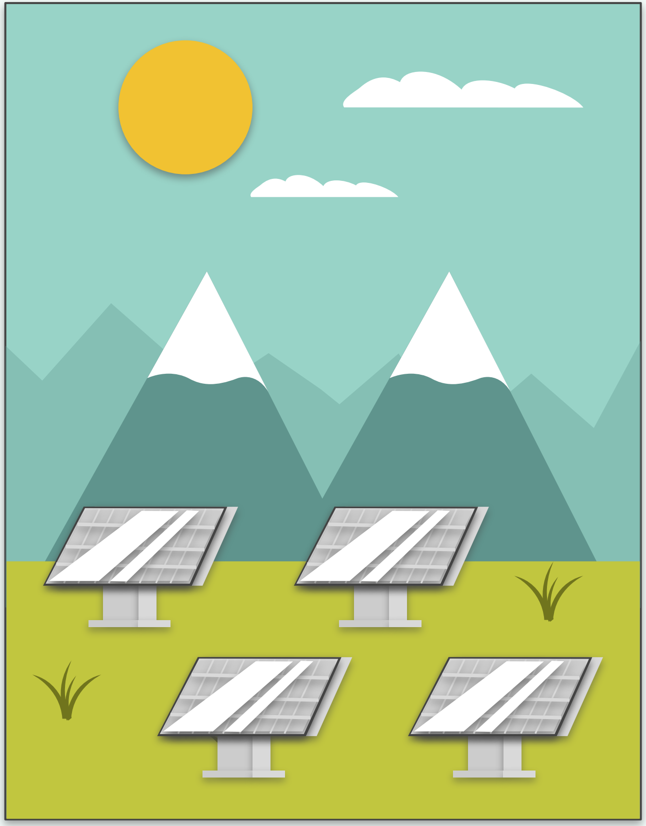
Enhanced Durability

Stronger table material, including an improved waterproof box.

03

Better Looks

Improve project's outer design

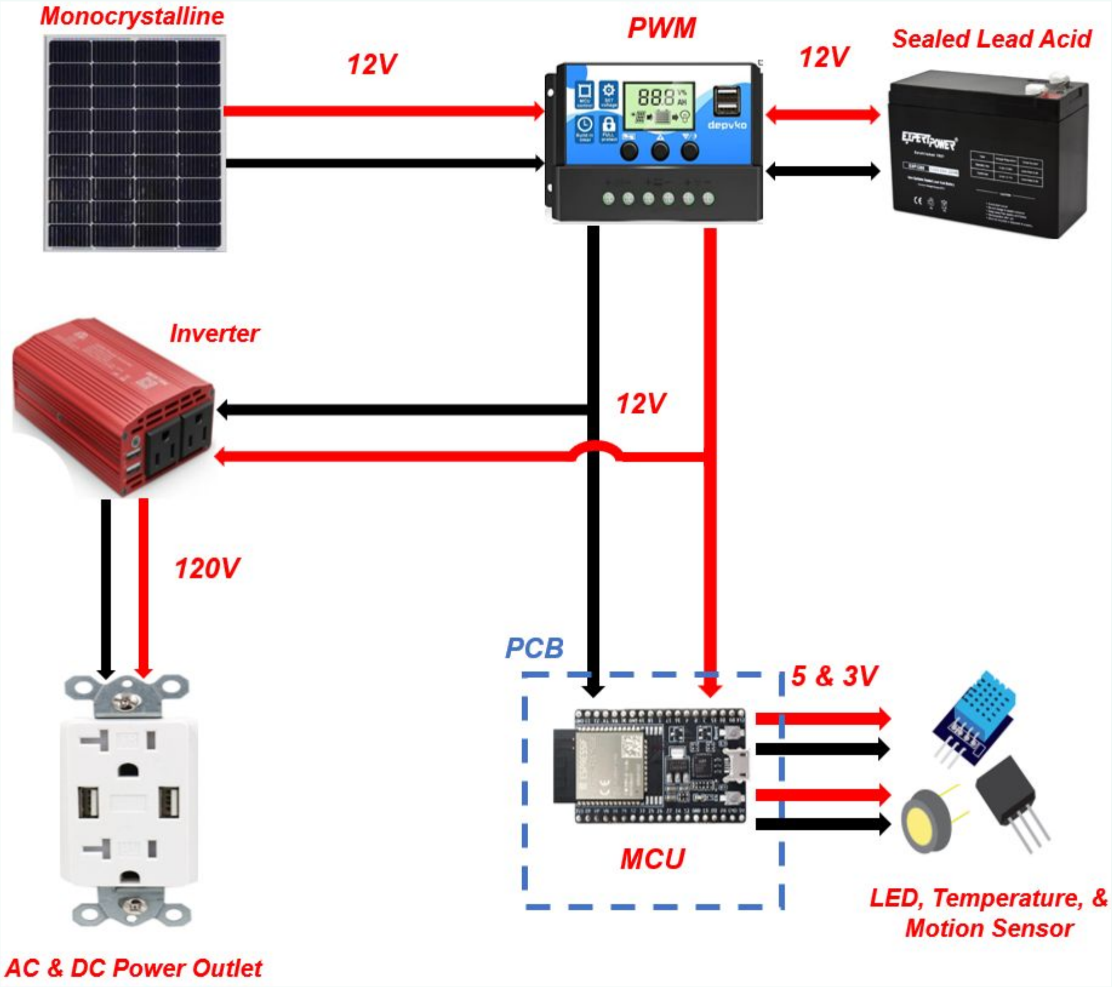


Specifications and Requirements

Engineering Requirement	Specification
Table dimensions	≤ 5.5′ x 5.5′ x 4′
Pole height	≤ 6′
Power generated by solar panel	≥ 40W
DC to AC inverter capacity	250W ≤ C ≤ 150W
Battery running time	≥ 6 hours
Battery charging time	≤ 5 hours
MCU BLE delay	3-10 ms
Motion sensor range	Within 4 feet

Electric Power Flow

- Goal is to provide power to both AC & DC loads.
- PCB regulates Voltage to sensors, LED and MCU.
- Inverter converts current to AC steps voltage up



PV Panel, Charge Controller, & Battery

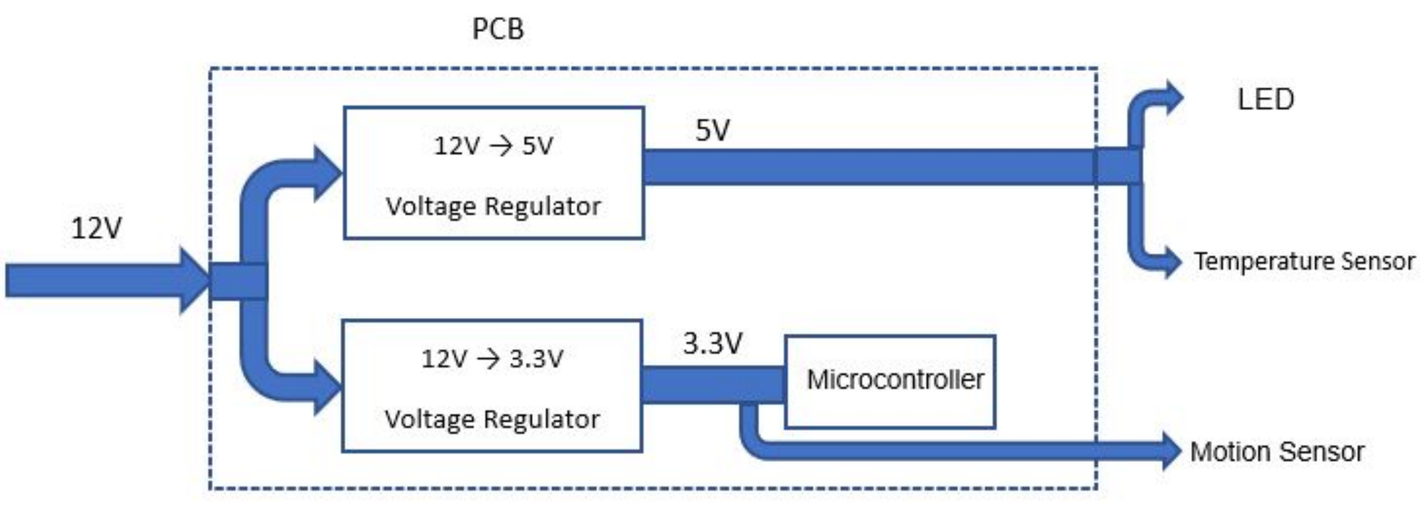
	PV Panel		Charge Controller		Battery	
Type	**Monocrystalline**	**Polycrystalline**	**PWM**	**MPPT**	**Lead-Acid**	**Lithium-ion**
Efficiency	15-24%	13-16%	75-80%	93-97%	80-85%	90-99%
Cost	1-1.5 $/watt	1 $/watt	10-60$	30-200$	Cheaper	Expensive
Comments	50W NEWPOWA 12V		DEPVKO PWM 12V 30 A		ExpertPower EXP1280 12V 8AH	

AC & DC Power Outlet

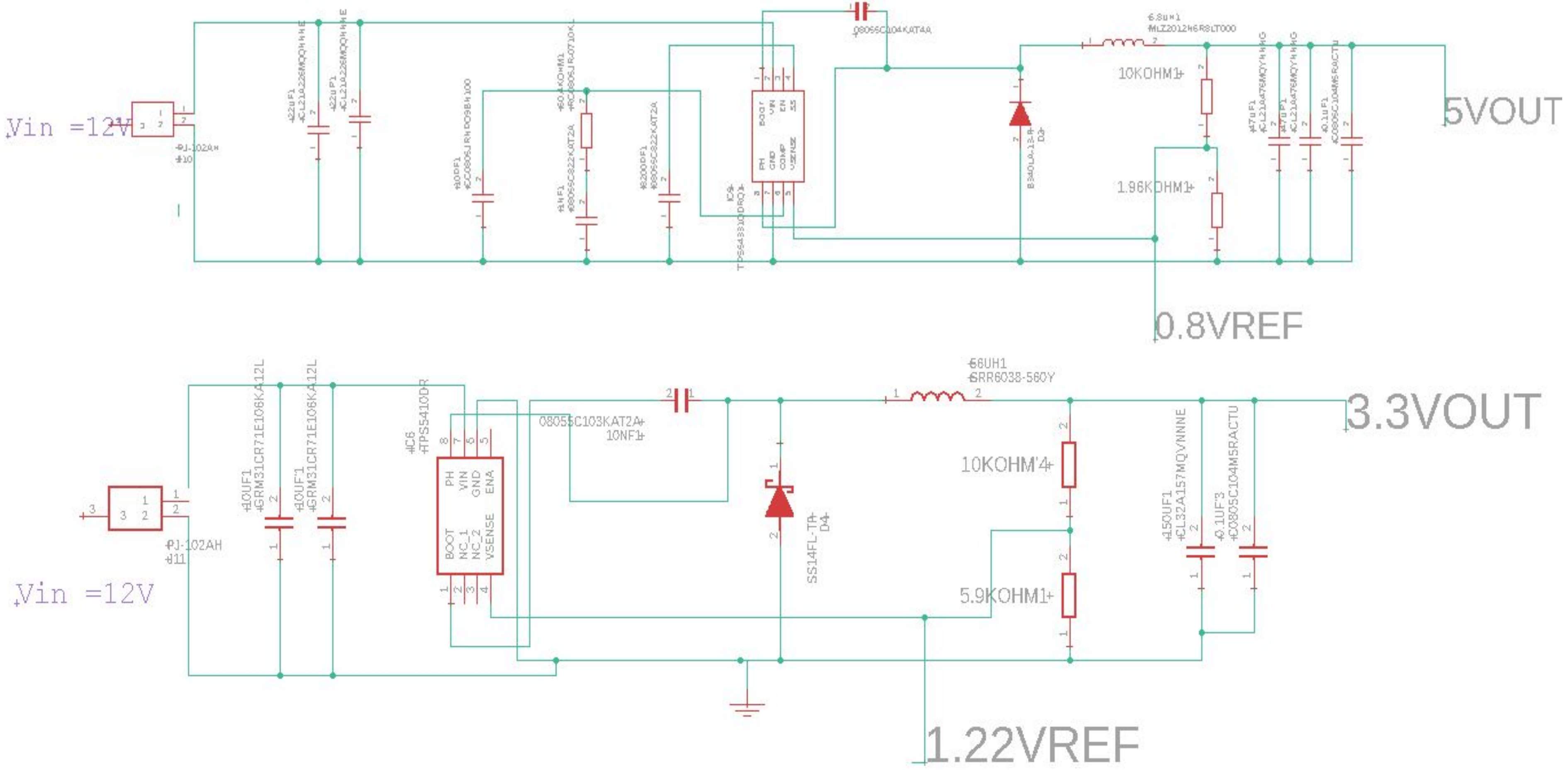
	Pure Sine Wave	Microinverter
Output Waveform	High Quality AC	Lower Quality AC
Performance	-Higher Efficiency -Higher Lifespan	-Less efficient but handles higher power output -More Maintenance
Installation	Can be connected to multiple PV panels	Used for a single PV panel
Cost	Cheaper (more common)	More expensive

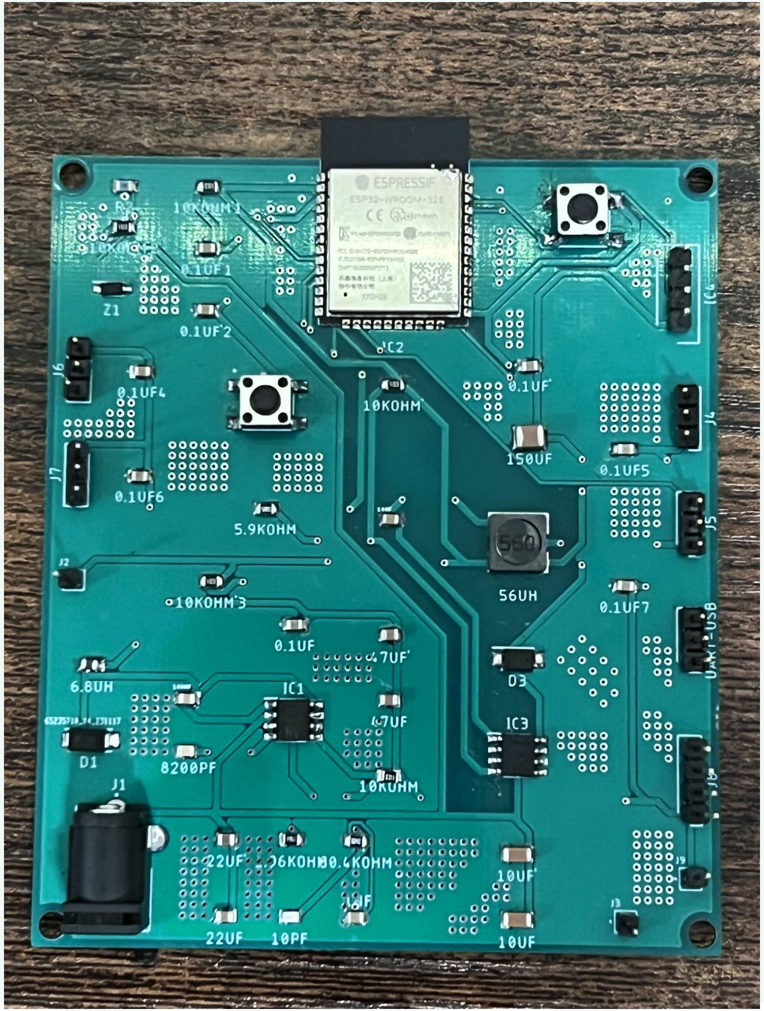
Voltage Regulator PCB(Will change)

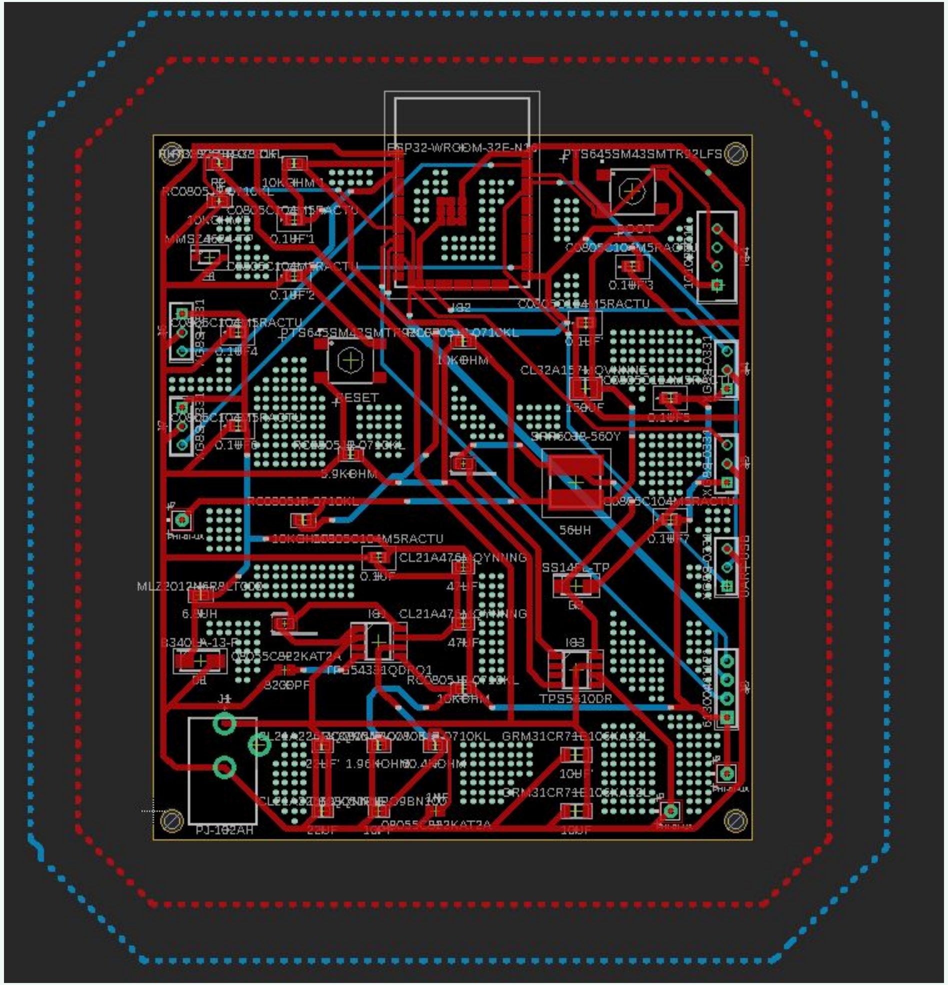
	Typical Voltage input (V)	Current input (A)
ESP32 MCU	3.3	0.5
AM312 Motion Sensor	3	15e-6
DHT22 Temp Sensor	5	1.25e-3
LED	5	1



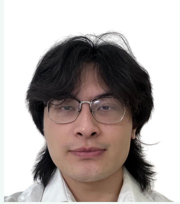
$$Vout = Vref * ((R1 + R2) / R2)$$




ESPRESSIF
ESP32-WROOM-32E
R2
10KOHM1
0.1UF1
Z1
0.1UF2
IC2
J6
0.1UF4
J7
0.1UF6
10KOHM
0.1UF
150UF
0.1UF5
IC4
J4
J5
5.9KOHM
J2
10KOHM3
56UH
0.1UF7
UART-USB
0.1UF
47UF
6.8UH
IC1
D3
47UF
IC3
D1
8200PF
10KOHM
J1
22UF
10UF
22UF
10PF
10UF
J8
J9
J3

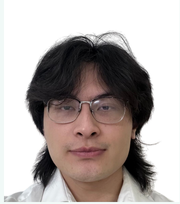


MCU Selection



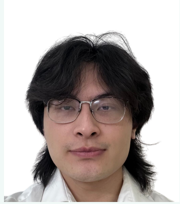
	ATmega 2560	ATmega 4809	ATSAMD21G1 A-AU	MSP430FR69 89	ESP32-WROOM-32E-N16
Pin #	86	41	53	83	32
Memory/RAM (KB)	256/8	48/6	256/32	128/2	4 MB/520
Power usage (mW)	0.9	0.36	0.108	0.185	.0252
Clock speed (MHz)	16	20	48	16	240
Price per unit (USD)	20.18	1.85	4.41	4.99	3.6

ESP32



- Equipped with 32 programmable pins
- Bluetooth and Wifi capabilities
- 4 MB of flash memory
- 520 KB of RAM
- Low power consumption
- High clock speed
- Cheap

Motion Sensing Technology



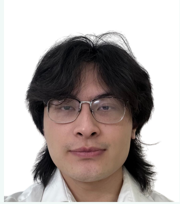
The motion sensor will be responsible for controlling the LED.

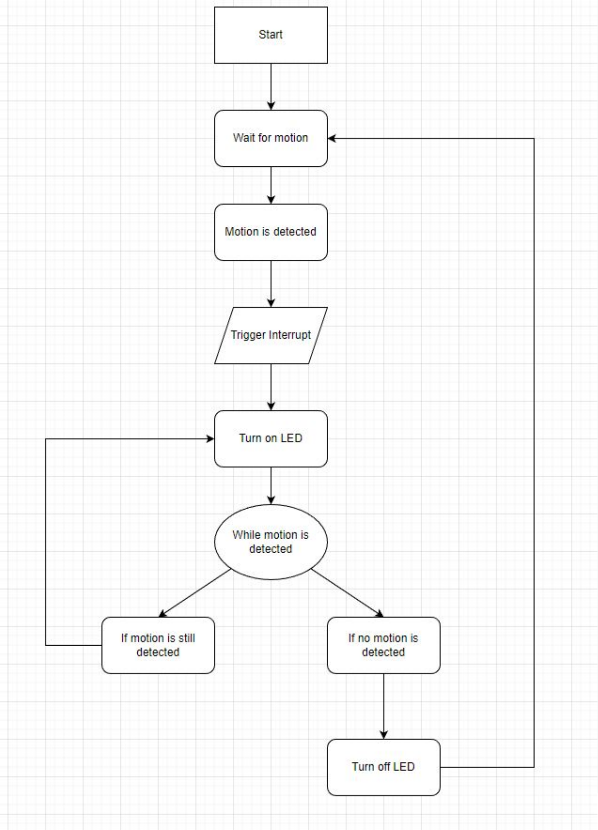
For this project, we decided that PIR sensor would be the best fit.

We decided to use the AM312.

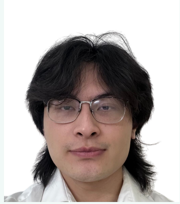
Technology	Pros	Cons
IR	Secure communication, resistant to environment, low power and cheap	Short distance, unable to penetrate hard objects, low area of effect
PIR	Excels in covering small or compact areas, low power consumption, cheap, reliable	Prone to hot temperature, low sensitivity
Microwave	Covers large area, high sensitivity	Can pick up unwanted movement, consumes more power, expensive
Ultrasonic	Senses any material, unaffected by environment like rain, high sensing distance	Sensitive to temperature changes, trouble reading echos from soft, thin, or curved objects

Motion Sensor Software Diagram



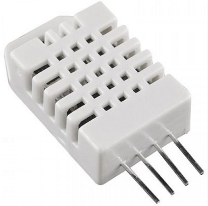


Temperature monitor selection



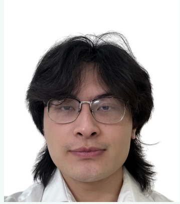
Our solar picnic table will be able to measure the surrounding temperature of the environment and display it to the user.

We decided that the DHT22 sensor would be the best fit for our table.



Sensor	Operating Voltage (V)	Range (°C)	Accuracy (°C)	Price per unit (USD)
DHT22	3-5	-40 to 80	+- 0.5	10
TMP36	2.7-5.5	-40 to 150	+- 2	3.89
LM35	4-30	-40 to 150	+- 0.5	2.6

Battery Monitor

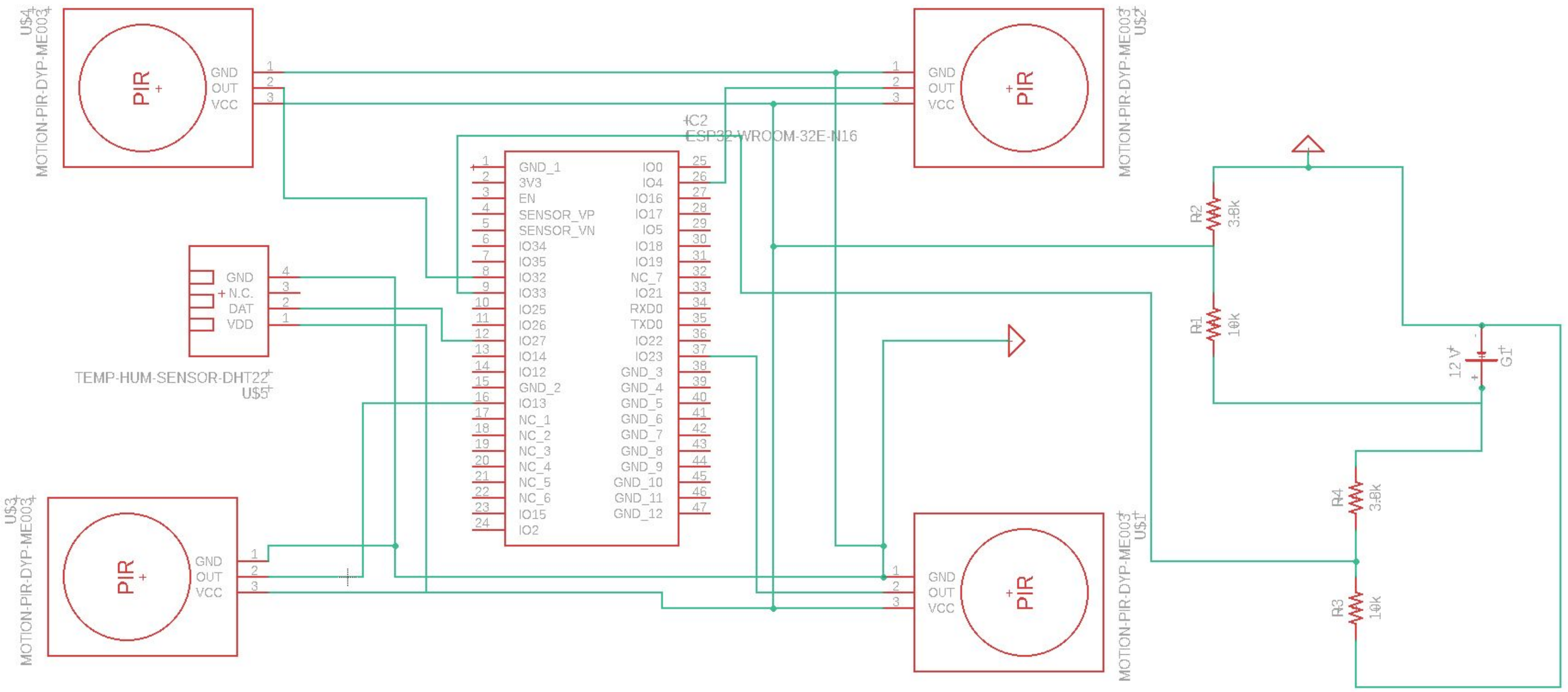


Another feature that is included in our solar picnic table is a battery monitor. This is important as it will tell the user how much power is available within the battery.

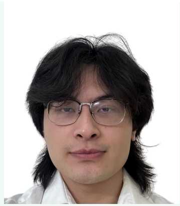
To monitor the battery, we decided to create our own voltage divider circuit.

	Pros	**Cons**
Voltage Sensor Module	Automatic,easier to use, little room for error	more expensive
Voltage Divider	Very cheap, easy to make	Must create manually, human error

MCU and Sensor Schematic

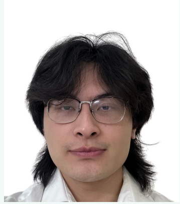


MCU and Sensor Interfacing

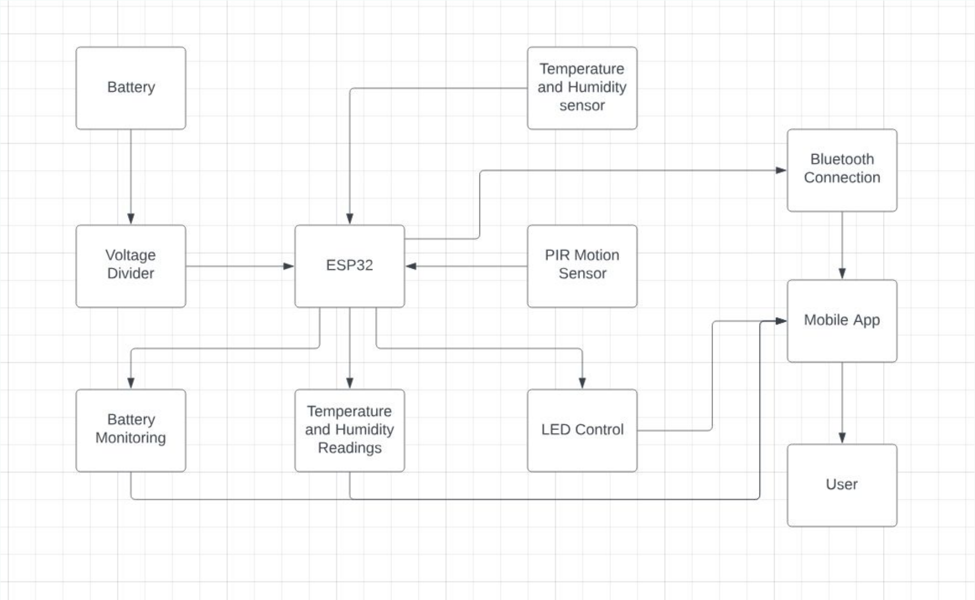


- Each sensor is connected to a GPIO pin on the MCU, the battery sensor will be connected using a ADC pin
- Battery sensor is built into the PCB for ease of implementation.
- The motion sensor and temperature sensor comes with libraries that contain functions which allow them to interact with the MCU.
- The code is created using C++ in the Arduino IDE.
- Communicates using 1-wire serial communication.

MCU Block Diagram



This diagram showcases how the MCU and external components are set up along with how they will interact with each other.



Software Connectivity

WiFi

- Longer Range
- Higher Speeds
- Better Security
- More Connections

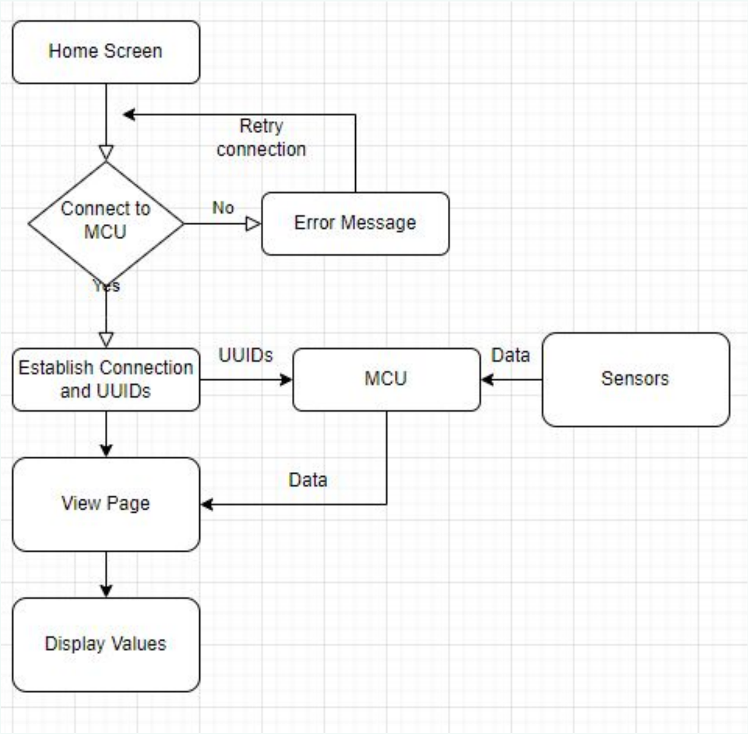
Bluetooth

- Lower Power Consumption
- Low Cost
- Ease of use

Software Platform

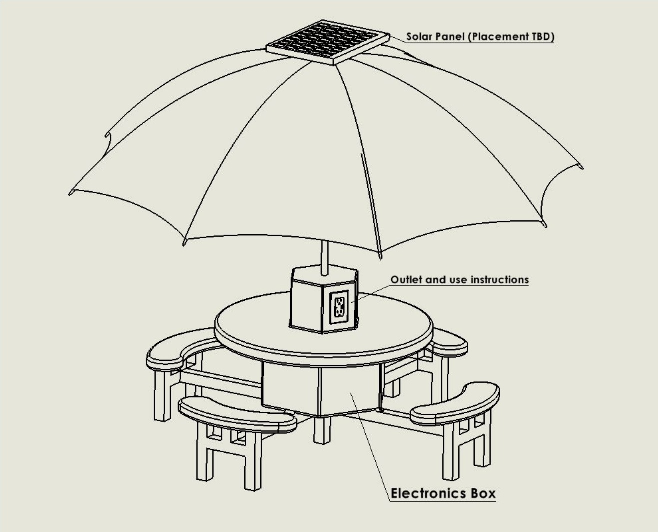
React Native	Flutter
• Large Community Support • Reusable code for website • Uses JavaScript	• Many options for UI Creation • Good Documentation • Larger community support • Uses Dart

Software Block Diagram



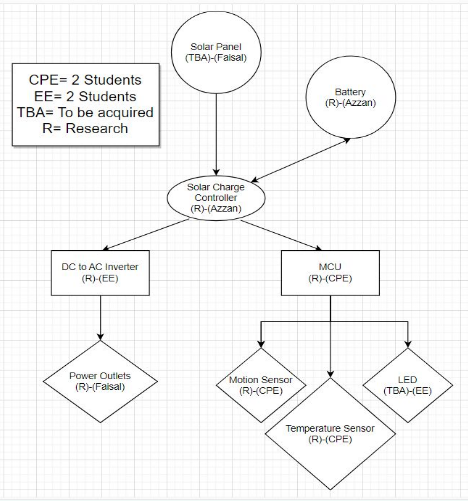
Project Assembly

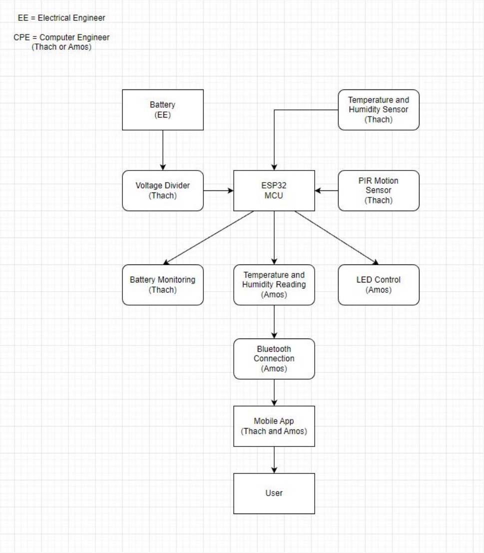
- 3 main components
    - Solar panel, Outlet box, Electronics Box



Work Distribution

- Two main sections
  - PCB/Power distribution, MCU/Software application





Finance and Budget

- A lot of research is done for each part
- Look for possible alternatives
  - Make parts ourselves

Quantity	Item	Vendor	Model	Price $
1	Solar Panel	Amazon	NPA100M	75
1	Battery	ExpertPower	EXP1280	24
1	Inverter	Amazon	B0774SCCND	15
1	Charge Controller	Amazon	B08NFSCZ4V	10
1	LED	Amazon	WS2812B	16
1	Microcontroller	Digi-Key	ESP32-WROOM-32E-N16E-N16	3.60
1	PCB	Digi-Key	-	17
1	Receptacle Outlet	Amazon	UR2-15TR	13
2	Temperature Sensor	Amazon	DHT22	2*5
4	Motion Sensor	Amazon	AM312	4*1.78
TOTAL				191

Challenges

- Sourcing a table
- Budget
- Weather conditions
- Finding location
- Shipping times