



Prince Mohammed Bin Fahd University  
College of Electrical Engineering  
Spring 2022

# Solar PV Based Charging Station for EV

Team members:  
Batool Alsunbul - 201700766  
Maha Alhajri - 201701472  
Raghad Alghamdi - 201700819  
Raghad Almutairi - 201701747  
Rania Alnassar - 201701166

Project Advisors:  
Dr. Samie Elnakla  
Mr. Saifullah Shafiq



# Meet Our Team



**Batool Alsunbul**

201700766



**Maha Alhajri**

201701472



**Raghad Alghamdi**

201700819



**Raghad Almutairi**

201701747

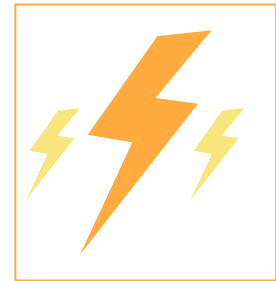


**Rania Alnassar**

201701166

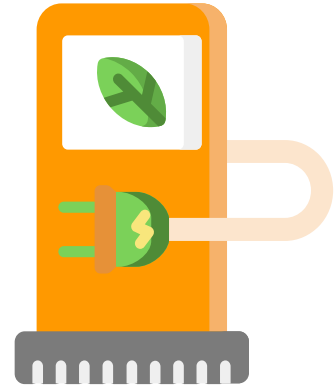
# Outline

- Project definition
- Project Objective
- Project Specification
- Project Architecture
- Project Constraints
- Planning
- Background: Problem & Solution
- Subsystems
- Safety
- Implementation
- Completed Work
- Project Management & Teamwork
- Risk Management
- Impact Of Project
- Skills Acquired & Applied
- Budget Estimate
- Video



# Project Definition

Design a stand-alone photovoltaic (PV) based charging station system for an electric vehicle (EV). Allows monitoring of the charging status through mobile application.



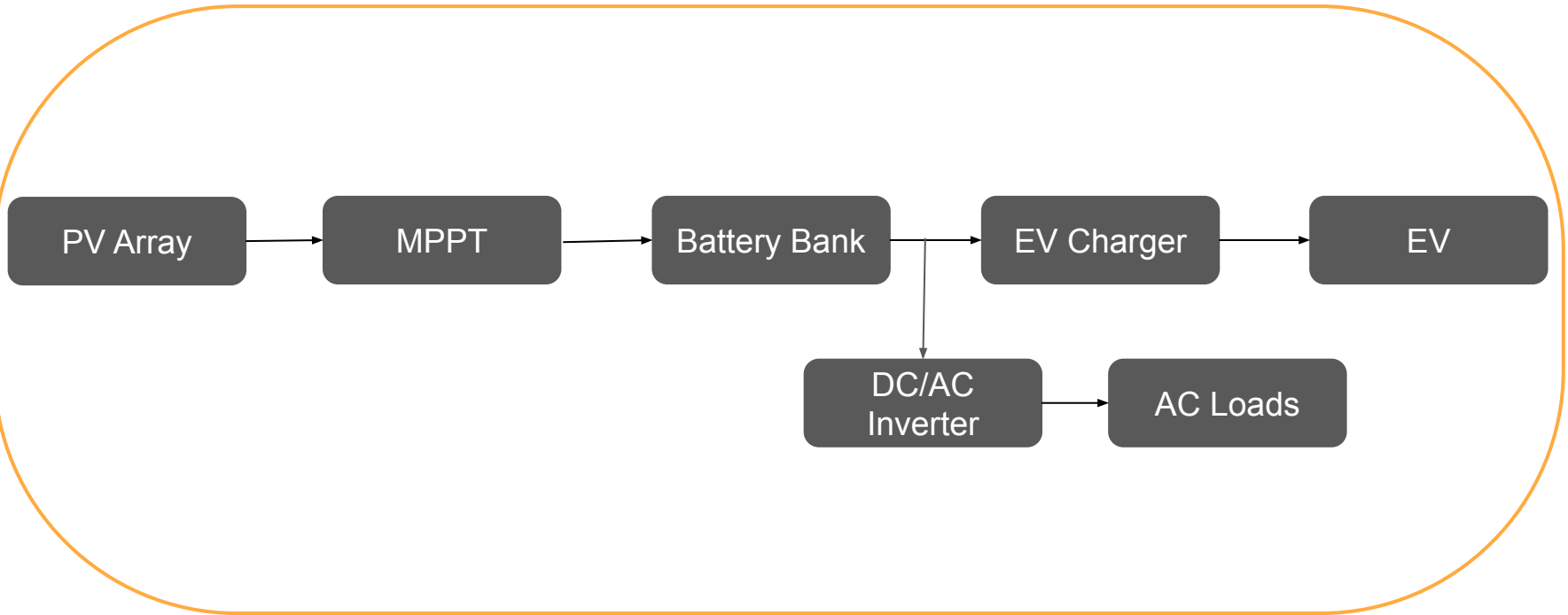
# Project Objective

- Develop environmentally friendly options of fueling EVs.
- Advance the adoption of zero emission vehicle technology.
- Increase dependence on renewable energy.
- Encourage environmentally friendly use of transportation with EVs and charging stations.
- Reduce the burden on the grid and use of EVs at remote locations.

# Project specifications

- Generates renewable energy using solar panels mounted on carport with maximum output of 480 Watts.
- Storage System with two 12 V 60 Ah batteries in 2S configuration.
- Battery charging time up to 3.7 hours.
- Charges EV with charger output of 48 V.
- Power AC loads of up to 150W.
- Circuit breakers for over current protection.
- Mobile application to display the battery status to the user.

# Project Architecture



**USER INTERFACE**

# Project Constraints

Economic

Safety

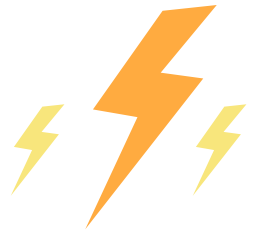
Environmental

# Planning

Title: Solar PV Based Charging Station for Electric Vehicles (E) Advisor: Dr. Samir Elnakhla							Design II (ASSE 4)		Spring 2022												
Batool Alsunbul (BS) 201700766							Project PLAN & Progress														
Raghad Alghamdi (RG) 201700819							ProgRpt No. 5														
Raghad Almutairi (RM) 201701747							Plan updated (Date): May. 17, 2022														
Rania Alnassar (RN) 201701166							Instructor: Dr. Sadiq Alhuwaidi														
Maha Alhajri (MH) 201701472							Period Highlight: 1		Plan		Actual										
							Actual (beyond plan)		% Complete (beyond plan)												
ACTIVITY	PLAN	PLAN	Assigned	ACTUAL	ACTUAL	PERCENT	Periods (Weeks 1-15)														
	START	DURATION	To	START	DURATION	COMPLETE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Write a plan	1	1	ALL	1	2	100%	█	█													
Subsystem 1 (Converter)							█	█													
Purchasing components for converter	1	2	RN	1	2	100%	█	█													
Designing the converter	1	2	RG	1	2	100%	█	█													
Design the PCB of the converter	3	1	BS	3		100%	█														
Implementation of the converter	6	1	BS, RG	4		100%	█	█	█												
Unit testing	7	1	BS, RG, RN	7		100%	█					█	█								
System verification and validation	7	1	BS, RG			100%						█	█								
Prepare midterm presentation and video	7	2	ALL	7	2	100%						█	█								
Subsystem 2 (Mobile App)							█														
System Design brainstorming	1	1	RM	1	1	100%	█														
Circuit Calculation and Design	2	1	RM	3	1	100%	█	█	█												
Purchasing components	4	2	RN	4		100%	█														
Circuit Connection	5	1	RM, MH	5		100%	█														
Programming	6	2	RM	6		100%	█														
Hardware and Software Integration	8	1	RM, RN			100%															
Testing system and data collection.	9	2	RM, RN, MH			97%															
IMPLEMENTATION																					
Breakers and fuse sizing and calculatins	2	1	BS	2	1	100%	█														
Breakers and fuse testing and implementantation	10	1	BS, RG			100%															
Integration of subsystem 1 and 2	10	1	ALL			100%															
Integration of whole system	10	2	ALL			100%															
System testing and data collection	10	1	RG, MH			100%															
AC load connection and implementing	10	1	MH, RN			100%															
Prepare final report	12	2	ALL			90%															
Prepare final presentation	12	2	ALL	12	3	100%															
Prepare project demo	13	3	ALL	13	3	98%															
Submit Rpt/PPT/Brochure/Video...etc.	14	2	BS	14	2	0%															

# Background: problem

- Electricity demand is rising
- Dependence on non-renewable energy
- Existing charging systems overloading grid
- Need for sustainable mode of transportation



# Background: Solution

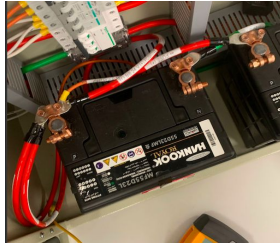
- Increase use of renewable energy such as solar power.
- Decrease the direct usage of fossil fuels.
- Solve the problem of grid overloading as well as in remote locations, where grid connectivity is an issue.



# Whole System



# Subsystems



Subsystem 1

Designing  
batteries and  
solar panels



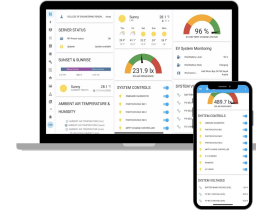
Subsystem 2

Designing  
carport and  
station



Subsystem 3

EV charger



Subsystem 4

Smart application

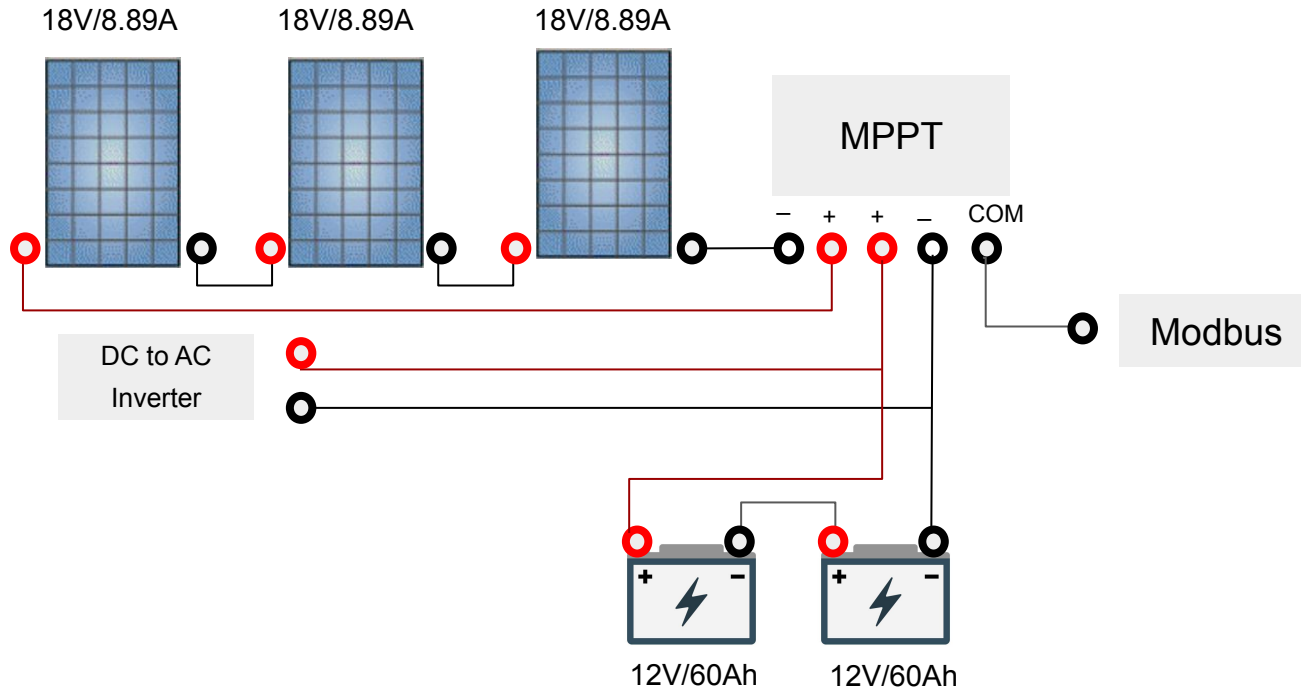
Subsystem 1

Subsystem 2

Subsystem 3

Subsystem 4

## Designing solar panels and batteries



## Design and build the structure of EV charging station



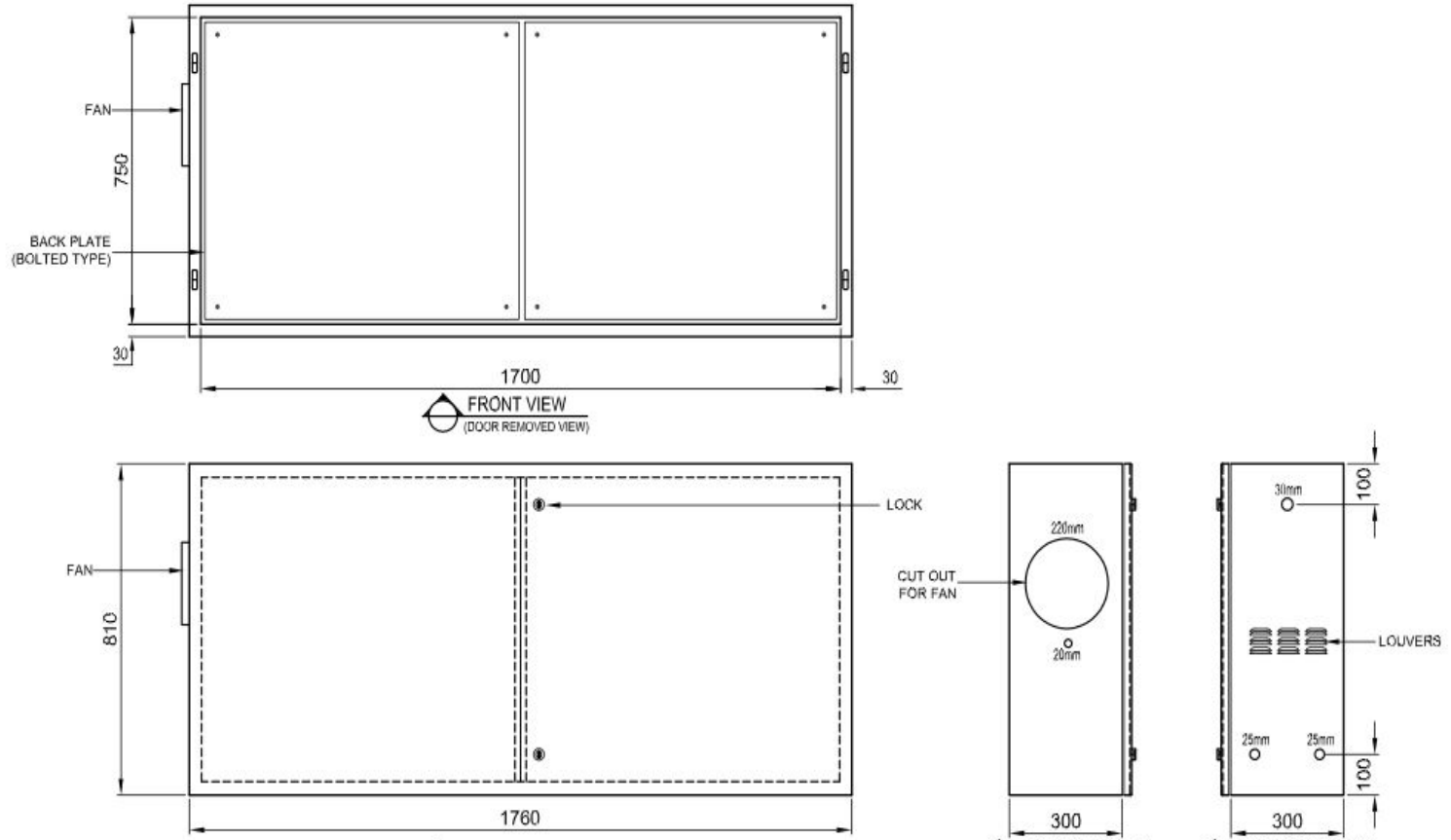
Testing angle of solar panels



EV charging station

## Design and build the structure of EV charging station

Ele



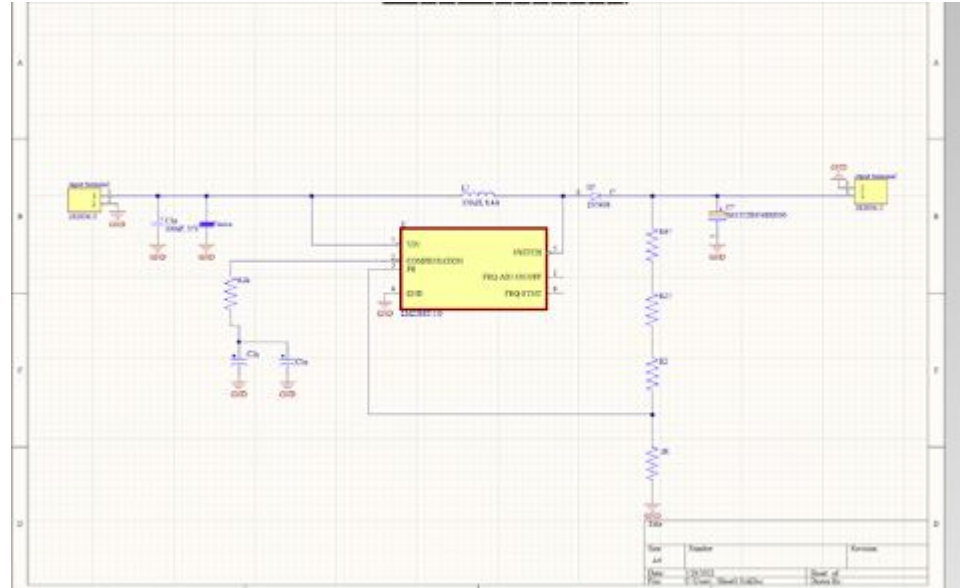
## Designing EV charger

### Boost DC to DC converter

- $V_{in} = 18V/36V$
- $V_{out} = 48V$
- $I_{in} = 6A$  max
- $I_{out} = 1.8A$

### Charge controller

- Voltage constant charging method



## Designing EV charger

### Boost DC to DC converter

- $V_{in} = 18V/36V$
- $V_{out} = 48V$
- $I_{in} = 6A \text{ max}$
- $I_{out} = 1.8A$

$$V_{OUT} = V_{REF} (1 + (R2+R3+R4)/R5)$$

### Charge controller

- Voltage constant charging method

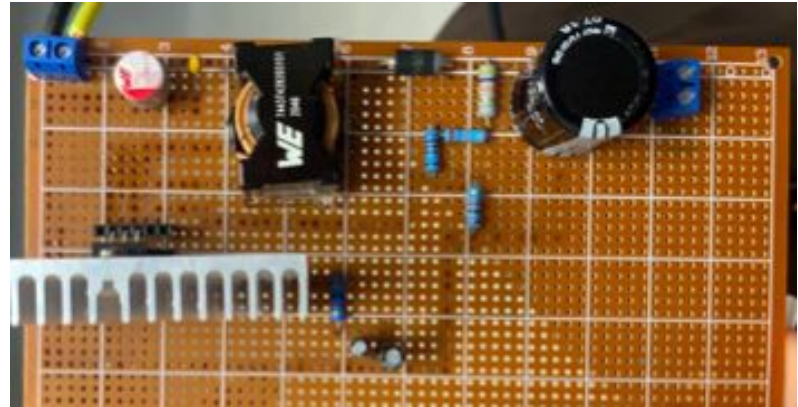
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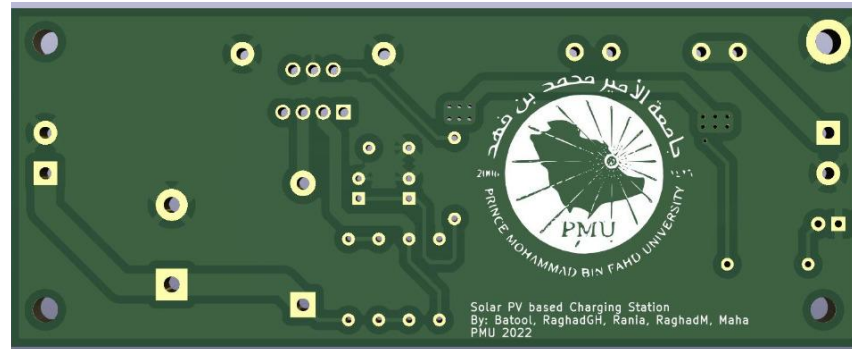
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## Designing EV charger

### Boost DC to DC converter

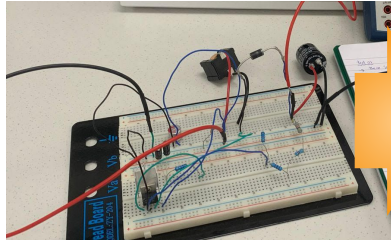
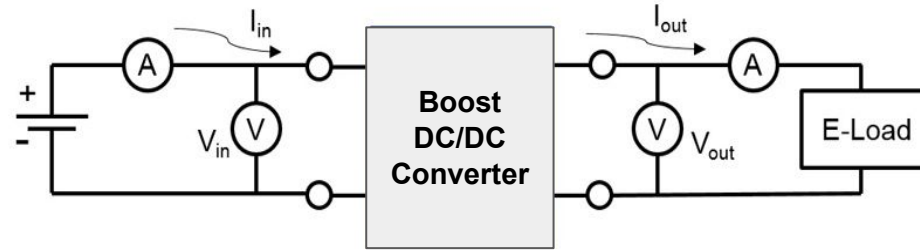
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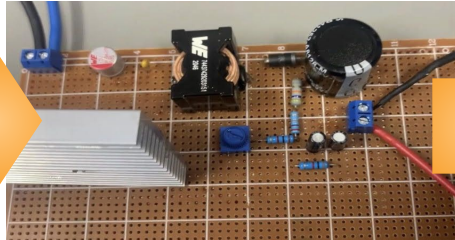
- Voltage constant charging method



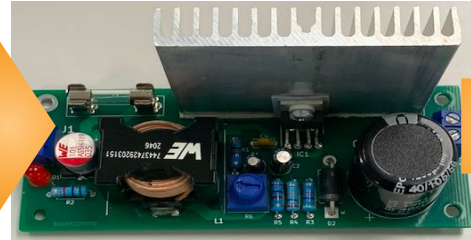
## DC to DC boost converter testing



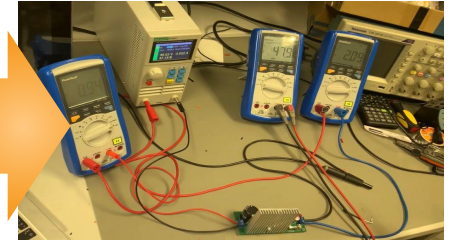
breadboard



Universal PCB



PCB

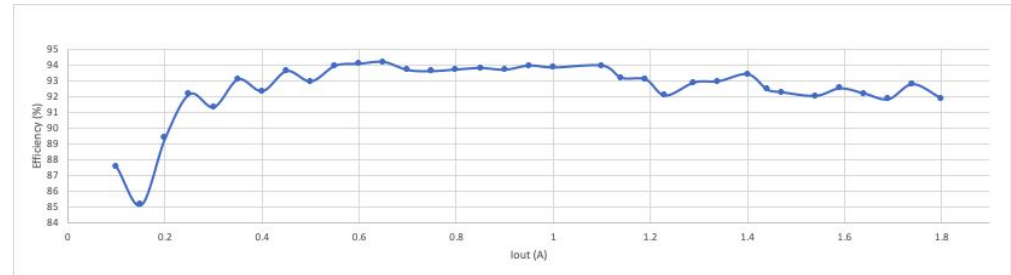


Testing converter

## Result of testing

Vin	In	Pin	Temp	Vout	Iout (A)	Iset (A)	Pout	EFF
24	0.24	5.76	25.2	50.4	0.1	0.1	5.04	87.5
24	0.37	8.88	25.4	50.4	0.15	0.15	7.56	85.1351351
24	0.47	11.28	25	50.4	0.2	0.2	10.08	89.3617021
24	0.57	13.68	25	50.4	0.25	0.25	12.6	92.1052632
24	0.69	16.56	25.2	50.4	0.3	0.3	15.12	91.3043478
24	0.79	18.96	24.6	50.4	0.35	0.35	17.64	93.0379747
24	0.91	21.84	24.3	50.4	0.4	0.4	20.16	92.3076923
24	1.01	24.24	24.2	50.4	0.45	0.45	22.68	93.5643564
24	1.13	27.12	24.7	50.4	0.5	0.5	25.2	92.920354
24	1.23	29.52	24.6	50.4	0.55	0.55	27.72	93.902439
24	1.34	32.16	24.6	50.4	0.6	0.6	30.24	94.0298507
24	1.45	34.8	24.4	50.4	0.65	0.65	32.76	94.137931
24	1.57	37.68	24.4	50.4	0.7	0.7	35.28	93.6305732
24	1.68	40.32	24.6	50.3	0.75	0.75	37.725	93.5639881
24	1.79	42.96	24.9	50.3	0.8	0.8	40.24	93.6685289
24	1.9	45.6	25.1	50.3	0.85	0.85	42.755	93.7609649
24	2.01	48.24	25.5	50.2	0.9	0.9	45.18	93.6567164
24	2.12	50.88	25.3	50.3	0.95	0.95	47.785	93.9170597
24	2.23	53.52	25.6	50.2	1	1	50.2	93.7967115
24	2.45	58.8	25.8	50.2	1.1	1.1	55.22	93.9115646
24	2.56	61.44	26	50.2	1.14	1.15	57.228	93.1445313
24	2.67	64.08	25.5	50.1	1.19	1.2	59.619	93.0383895
24	2.79	66.96	25.7	50.1	1.23	1.25	61.623	92.0295699
24	2.9	69.6	26.5	50.1	1.29	1.3	64.629	92.8577586
24	3.01	72.24	25.9	50.1	1.34	1.35	67.134	92.9318937
24	3.13	75.12	26.5	50.1	1.4	1.4	70.14	93.370607
24	3.24	77.76	27	49.9	1.44	1.45	71.856	92.4074074
24	3.36	80.64	26.4	50.6	1.47	1.5	74.382	92.2395833
24	3.48	83.52	27	49.9	1.54	1.55	76.846	92.0090996
24	3.59	86.16	26.8	49.8	1.6	1.6	79.68	92.4791086
24	3.7	88.8	26.6	49.9	1.64	1.65	81.836	92.1576577
24	3.82	91.68	26.7	49.8	1.69	1.7	84.162	91.7997382
24	3.94	94.56	26.5	50.4	1.74	1.75	87.696	92.7411168
24	4.1	98.4	26.5	50.2	1.8	1.8	90.36	91.8292683

**Average efficiency : 92.47%**



Subsystem 1

Subsystem 2

Subsystem 3

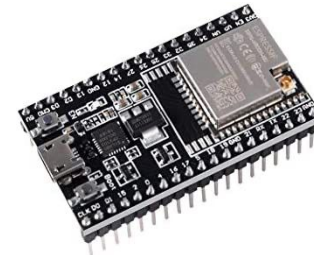
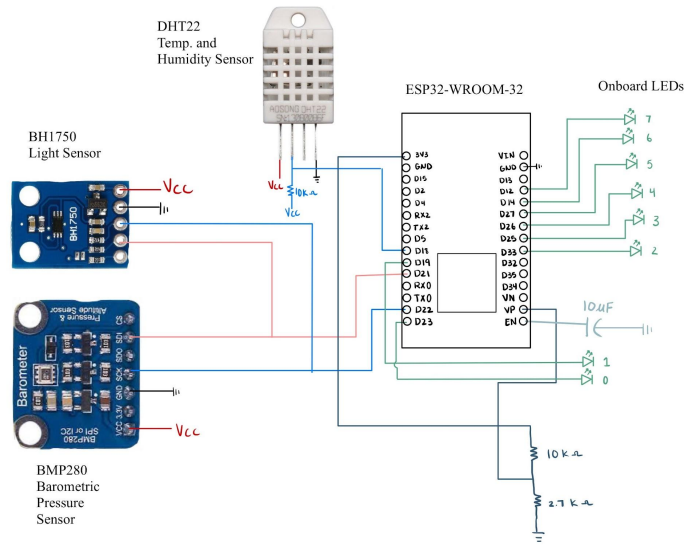
Subsystem 4

## Mobile Application

→ System Design

→ Software

# Mobile Application



ESP32 microcontroller



BH1750 Light Sensor

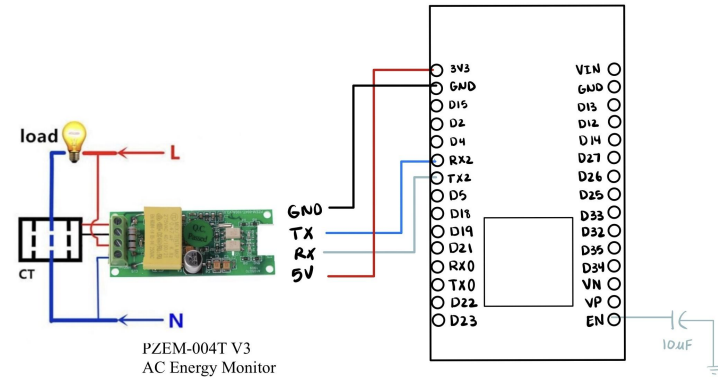
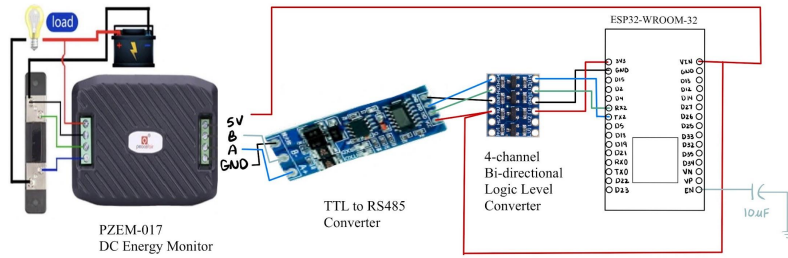


DHT22 Temp. and Humidity Sensor

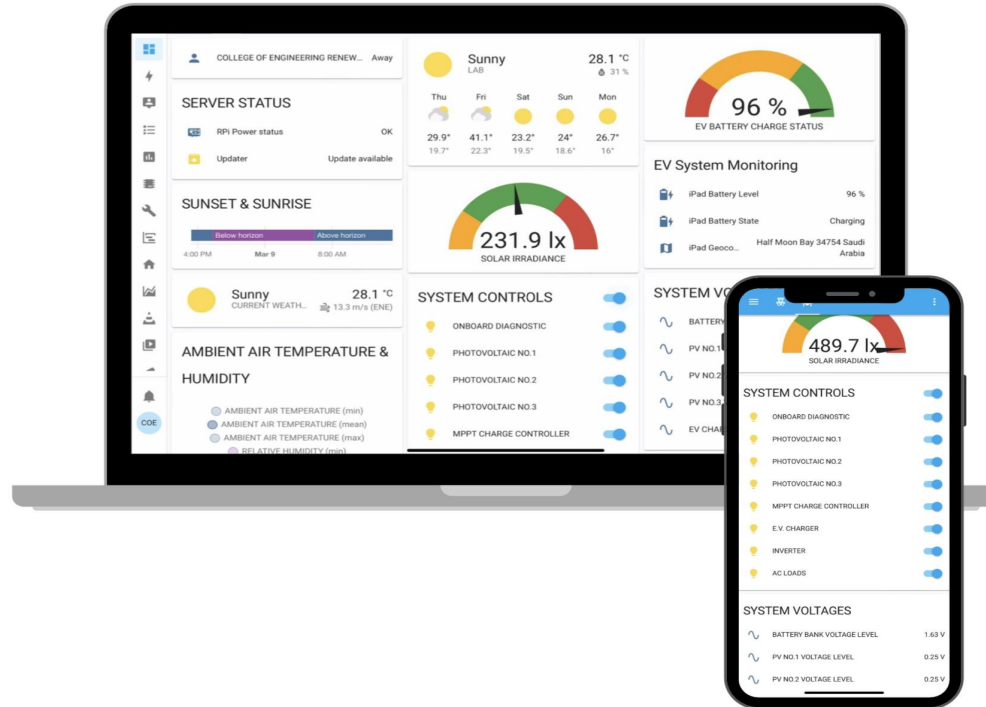


BMP280 Barometric Pressure Sensor

# Mobile Application

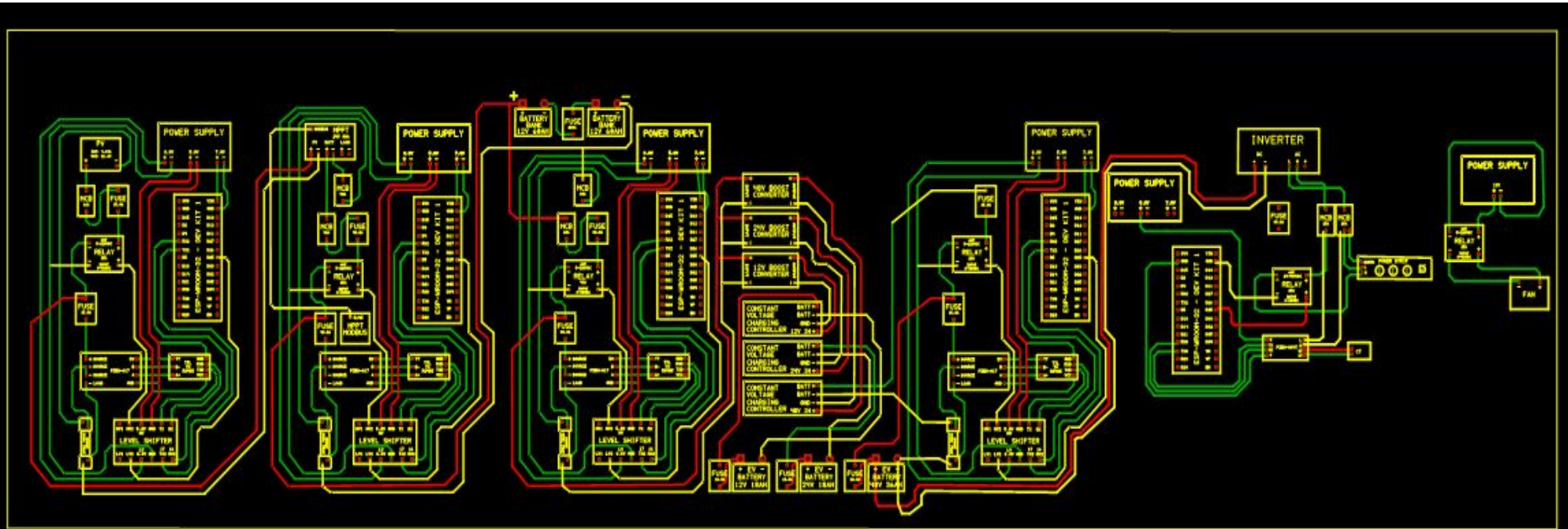


# Mobile Application



# Implementation

→ Wiring Diagram



# Implementation

## → Sizing of the wires

<b>Voltage (V)</b>	<b>Current (I)</b>	<b>Demand Factor (DF)</b>	<b><math>\varphi</math></b>	<b>NO D.F</b>
5V	5A	4	AWG 12 (2.08 mm <sup>2</sup> )	AWG 14
24V	60A	48	AWG 4 (16.8 mm <sup>2</sup> )	AWG 4
48V	7A	5.6	AWG 12 (2.08mm <sup>2</sup> )	AWG 13
220V	1.30A	1.04	AWG 12 (1.31mm <sup>2</sup> )	AWG 20
21.6V	9.69A	7.752	AWG 10 (3.32 mm <sup>2</sup> )	AWG 10

# Implementation



# Completed work

- Subsystem 1
- Subsystem 2
- Subsystem 3
- Subsystem 4

# Project Management and Teamwork

Task	Batool	Maha	Raghad G.	Raghad M.	Rania
Search & acquire components	20%	20%	20%	20%	20%
Design & Implement Subsystem 3	40%	0%	40%	0%	20%
Design & Implement Subsystem 4	0%	40%	0%	40%	20%
Testing	20%	20%	20%	20%	20%
Write Reports & Presentations	20%	20%	20%	20%	20%

# Risk Management

#	Risk Description	Risk Management	Impact
1	Material Arrival	Keeping in touch with supplier	Delays in project planning
2	Budget Management	Cheaper alternatives	High quality and matching needs
3	Circuit Design Testing and Troubleshooting	Better component selection, proper system calculation	Added material cost and time delay

# Impact of Project

- Solar power systems harness the sun's clean, and pure energy. So by installing solars to charge EV's will help reduce greenhouse gas emissions and our need of fossil fuels.
- Electricity bills can be reduced or eliminated entirely.
- The expense of on-grid increases over time, whereas off-grid continues to generate electricity at no additional cost.

# Skills Acquired and Applied

- Programming
- Solidworks
- Altium Designer
- Time Management
- Teamwork
- Circuit Design
- Hardware and software integration
- Material/Component Selection

# Budget Estimate

No.	Description	Quantity	Unit Price (SAR)	Total Price (SAR)
1	<b>EV Battery</b>	4	Collaboration with Mech Eng EV	
2	<b>Storage Battery</b>	2	Donation from old project	
3	<b>Solar Panels</b>	3	Donation from old project	
4	<b>MPPT</b>	1	617	617
5	<b>Components of DC to DC Converter</b>	LOT	736	736
6	<b>Electronic DC Load tester</b>	1	681	681
7	<b>AC Energy Monitoring Module</b>	2	36	72
8	<b>DC Energy Monitoring Module</b>	7	46	322
9	<b>Light sensor</b>	2	70	140
10	<b>ESP32</b>	3	13.81	41.43

# Budget Estimate

11	<b>EV charging Station Structure</b>	2	1000	2000
12	<b>Circuit breakers</b>	8	Donations from old project	
13	<b>Fuse box</b>	3	61.11	183.33
14	<b>Medium Blade Fuses</b>	1	30.41	30.41
16	<b>DC-AC Inverter</b>	1	511.52	511.52
17	<b>DC &amp; AC Wires</b>	LOT	884	884
18	<b>Raspberry Pi</b>	1	Borrowed from university	
<b>Total</b>				6,218.69

<https://youtu.be/zsD32Q0q5Cw>

**THANK YOU**