جامعة الأمير محمد بن فهد
2006
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PMU
PRINCE MOHAMMAD BIN FAHD UNIVERSITY

SMART SOLAR CARPORT SYSTEM

TEAM MEMBERS

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AGENDA

01 PROJECT DEFINITION AND OBJECTIVES

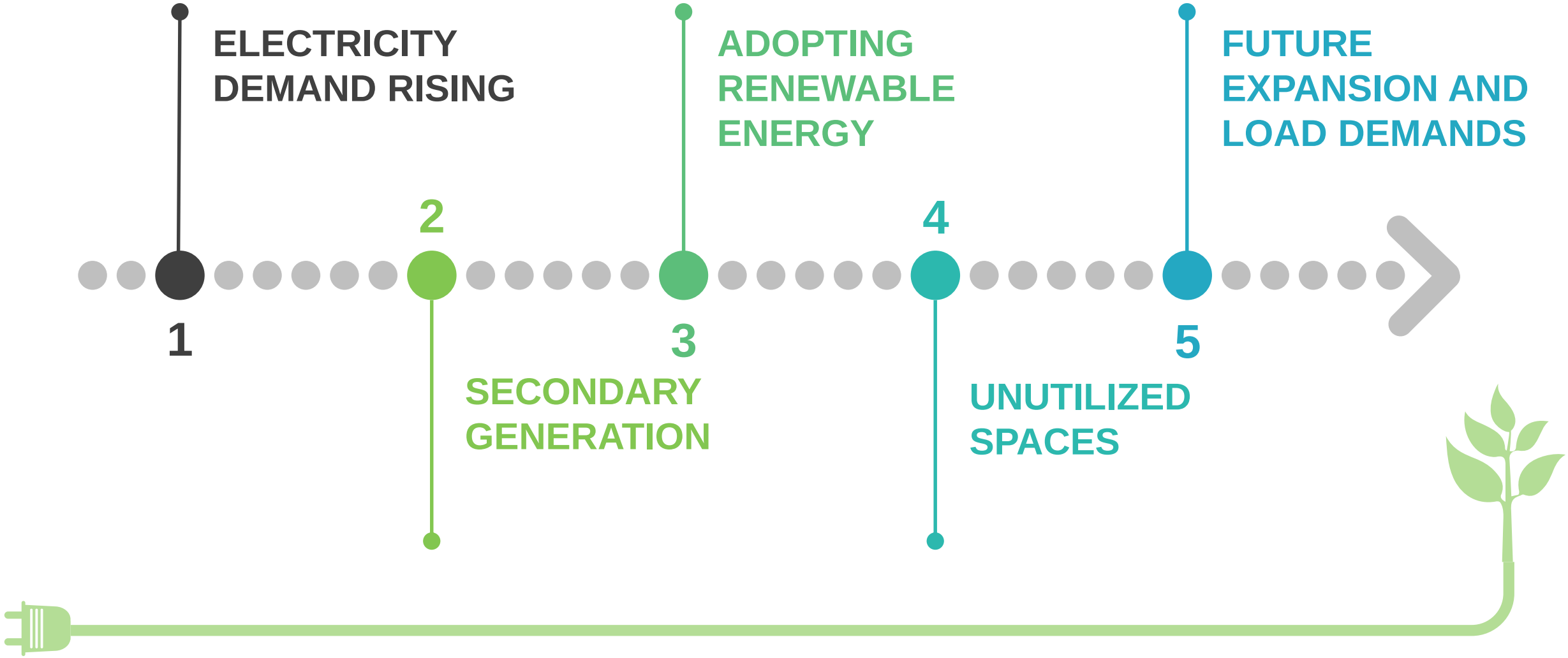
02 PROJECT SPECIFICATIONS AND BLOCK DIAGRAM

03 BACKGROUND AND PREVIOUS PROJECTS

04 SUMMARY, COMPARISON, AND BUDGET

05 PLANNING, PROGRESS, AND REFERENCES

BACKGROUND PROBLEMS

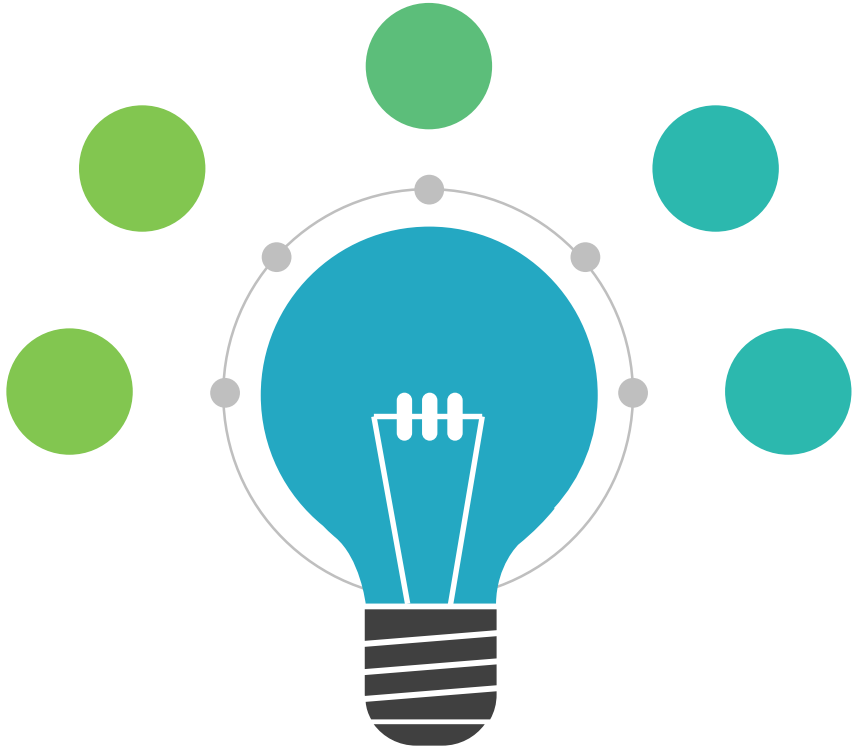


BACKGROUND SOLUTIONS

ENCOURAGE THE SOCIETY
TOWARDS RENEWABLE SYSTEMS

ADOPT ENERGY
STORAGE ELEMENTS

AFFORD ELECTRIC
VEHICLES

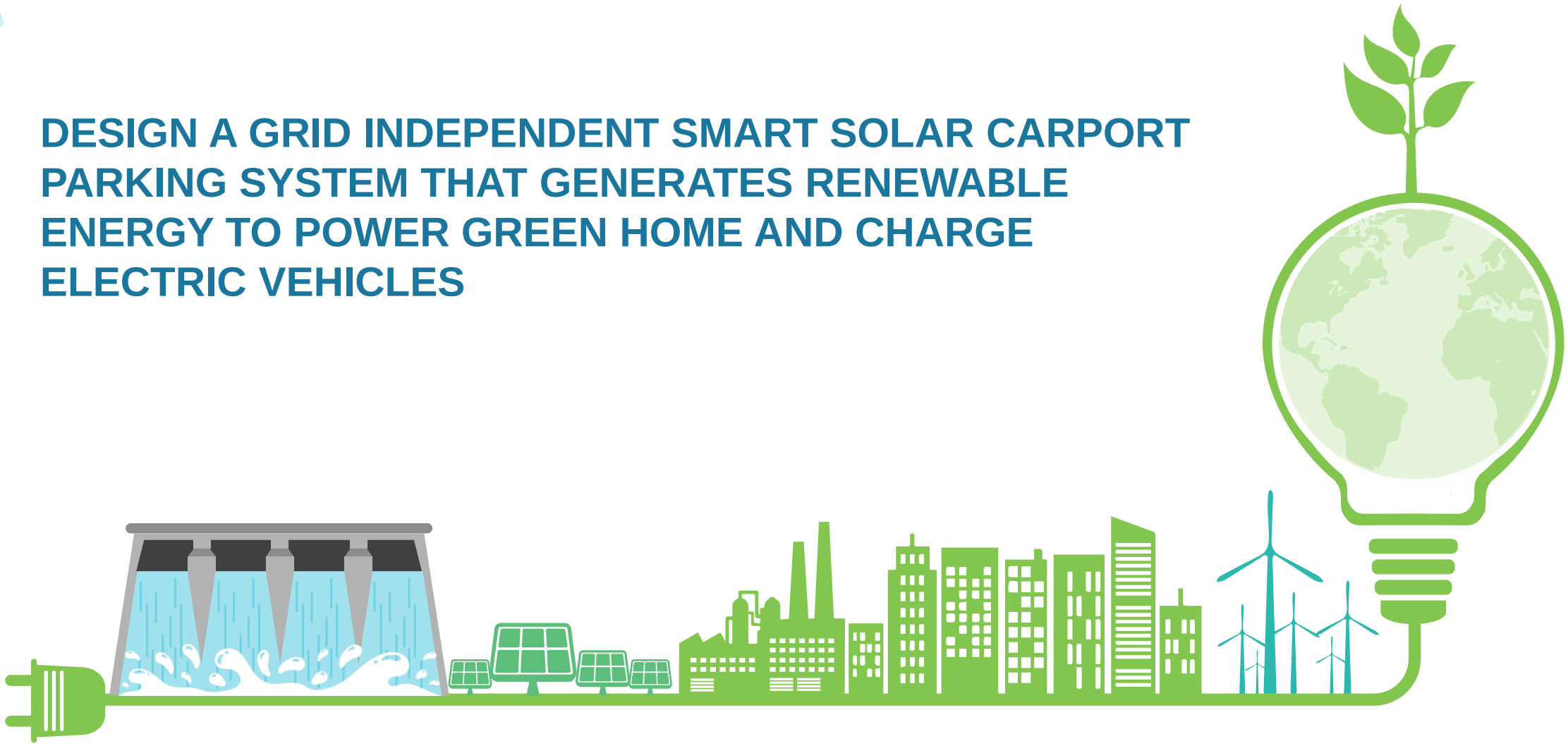


COVER PARKING SPACES
WITH SOLAR PANELS

UTILIZE
MULTIPURPOSE
POWER SYSTEMS

PROJECT DEFINITION

DESIGN A GRID INDEPENDENT SMART SOLAR CARPORT PARKING SYSTEM THAT GENERATES RENEWABLE ENERGY TO POWER GREEN HOME AND CHARGE ELECTRIC VEHICLES



PROJECT OBJECTIVES

Content Here
01

Generate renewable energy at PMU campus

Content Here
02

Reduce electricity expenditures and hedge against future cost increases .i.e, electric bills

Content Here
03

Improve parking experience for students, staff, and visitors

Content Here
04

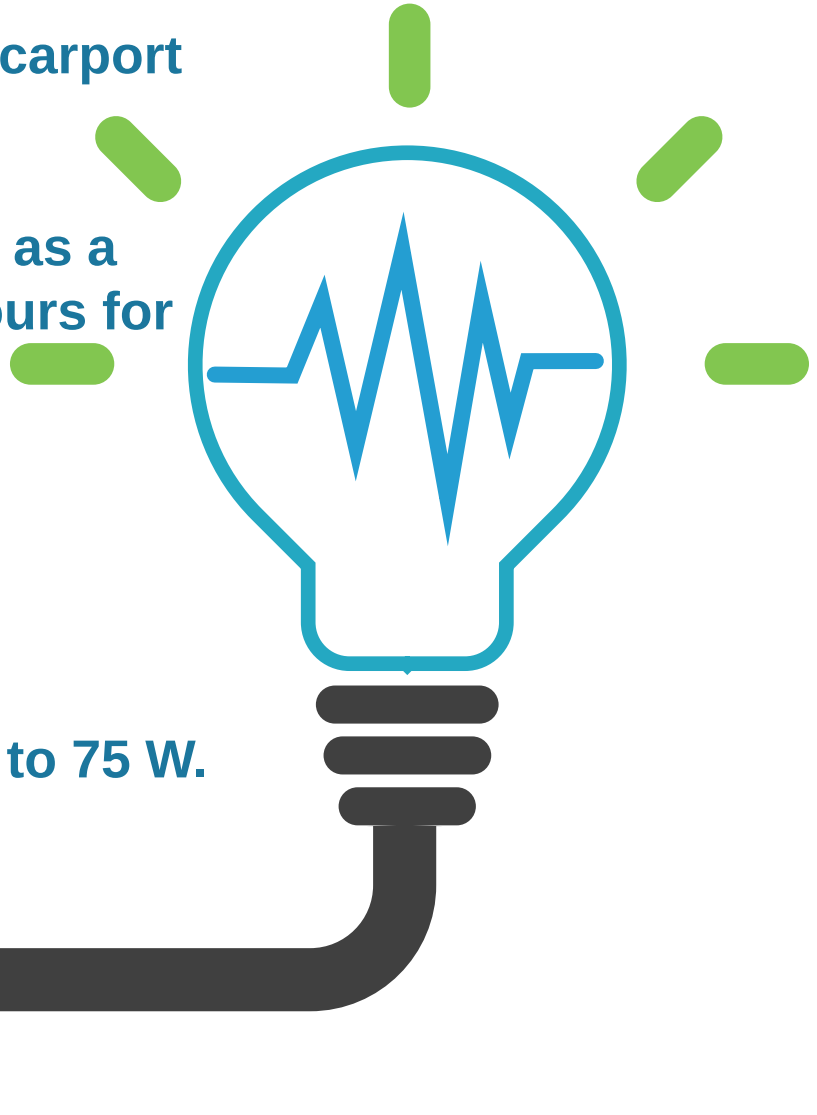
Afford electric vehicle (EV) charging station

Content Here
05

Encourage transportation towards renewable system

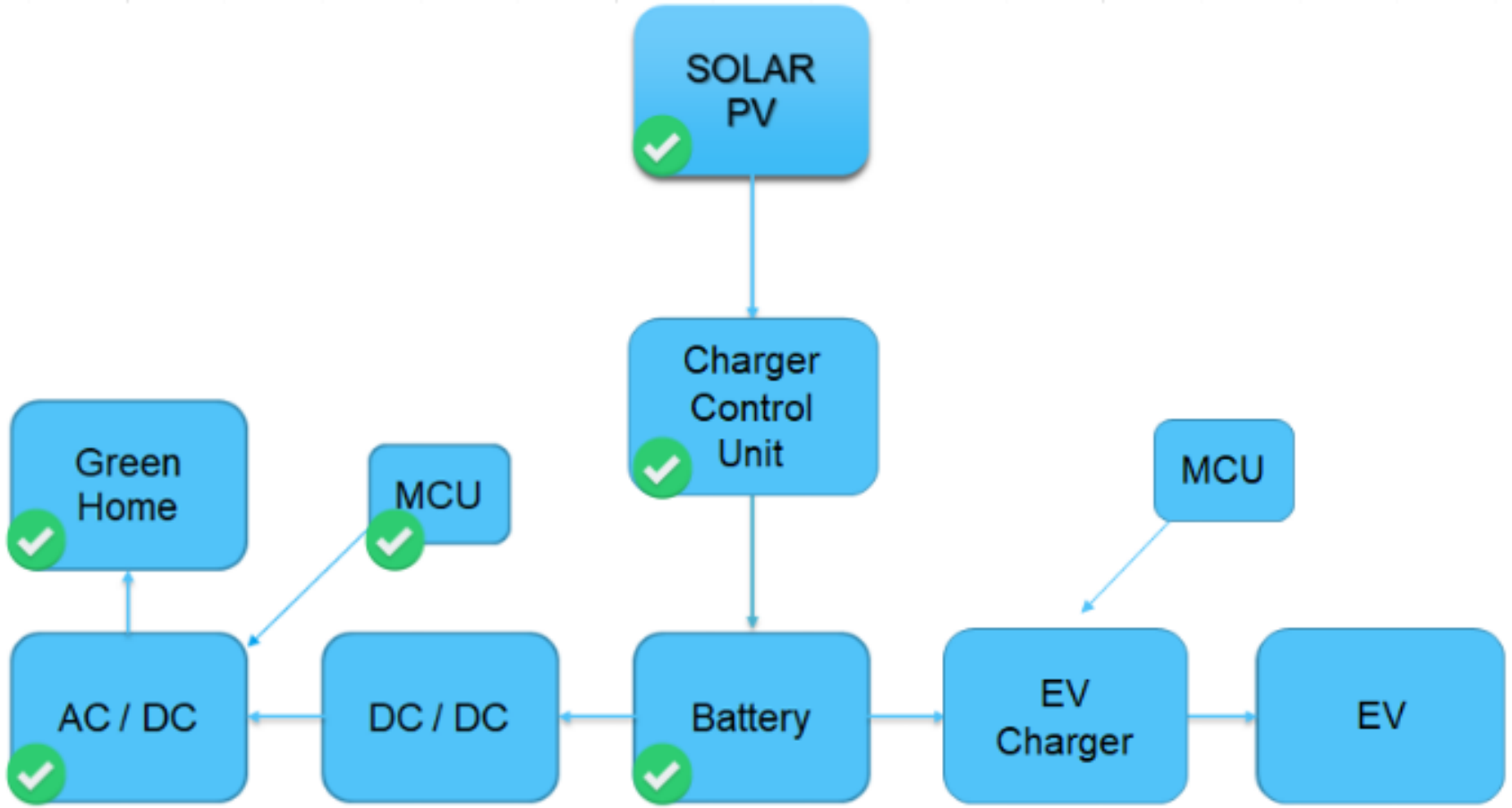
PROJECT SPECIFICATIONS

- Generates renewable energy using solar PV panels mounted on carport with maximum output of 480 W.
- Contains an energy storage (battery) for 150 Ah, 12 V which acts as a backup source capable to provide continuous power for 3.75 hours for maximum load of 480 W.
- Charges Electrical Vehicle (EV) with charger output of 220 V.
- Contains DC/AC Inverter with output of 75 W.
- Energizes electrical household appliances (residential loads) up to 75 W.



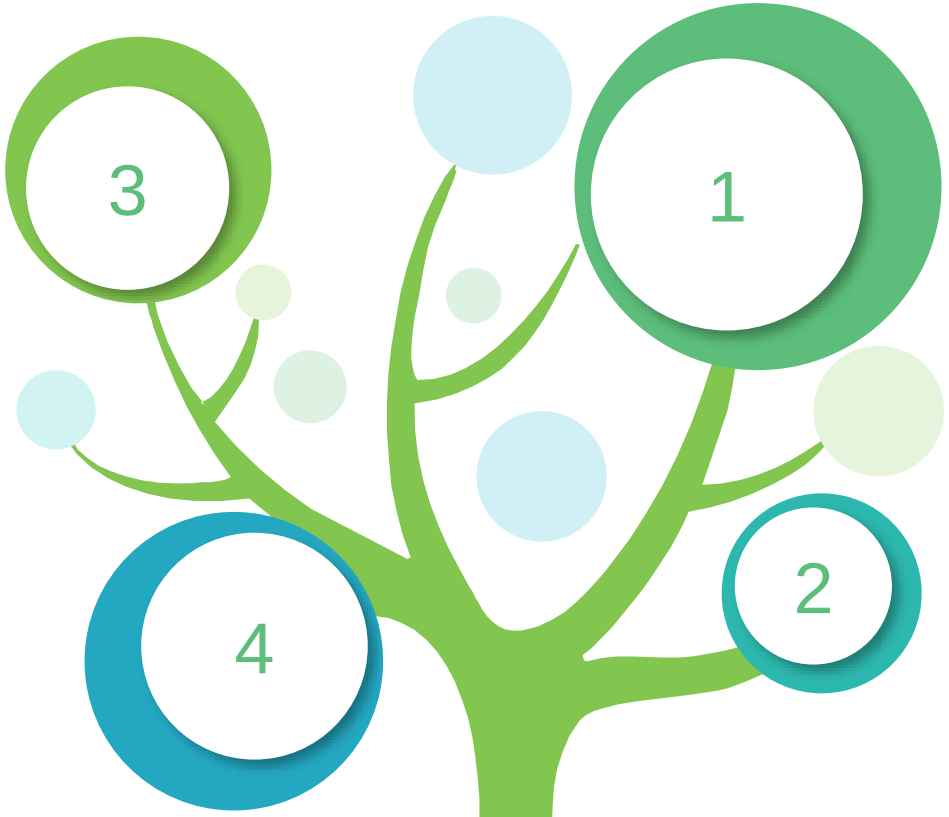
SMART SOLAR CARPORT SYSTEM

PROJECT DIAGRAM



PREVIOUS PROJECTS

SOLAR CARPORT DESIGN (PATENT APPLICATION PAPER)



SOLAR CARPORT

RENEWABLE RESIDENTIAL DISTRIBUTION SYSTEM

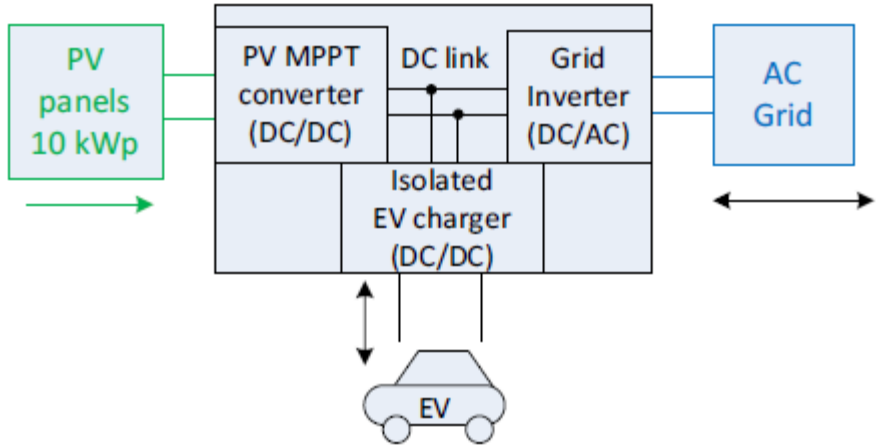
SOLAR CARPORT CHARGING STATION

Smart grid solar-powered charging station (2015, University of York)

- ESD developed solar powered charging station at York University, Canada
- Uses renewable energy, provide electricity, encourage the transport towards EV
- Increase electric mobility solutions on campus

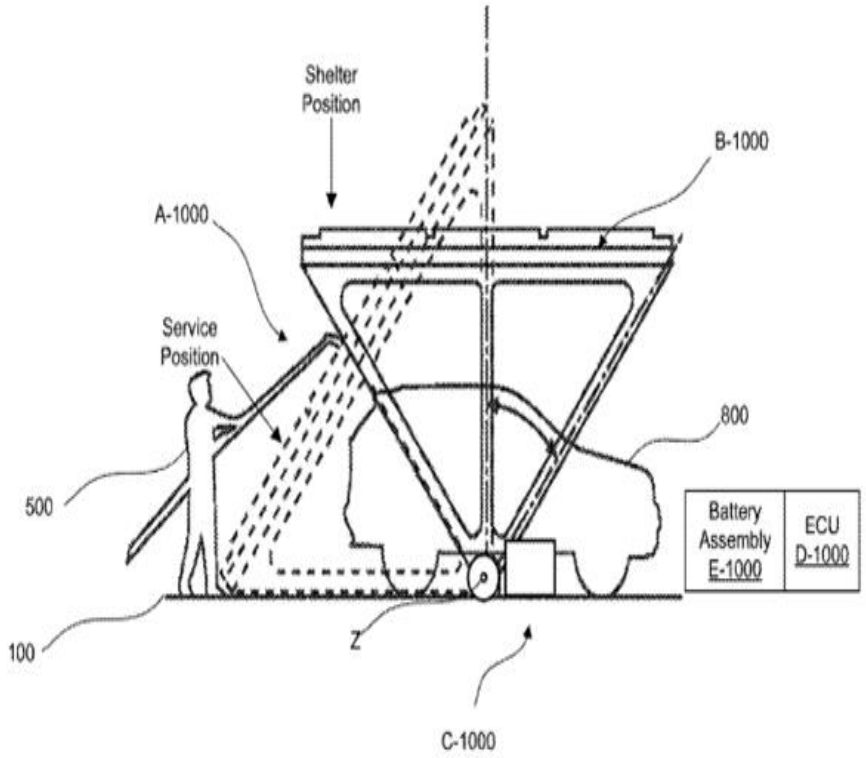
System design for a solar powered electric vehicle charging station for workplaces (2016, Department of Electrical Sustainable Energy, Delft University of Technology)

- Uses renewable energy source
- Investigates the possibility of charging battery EV at workplace using solar energy carport system
- Feasibility of battery bank, EV charging system and gird independent
- Provide method to overcome the PV variation.



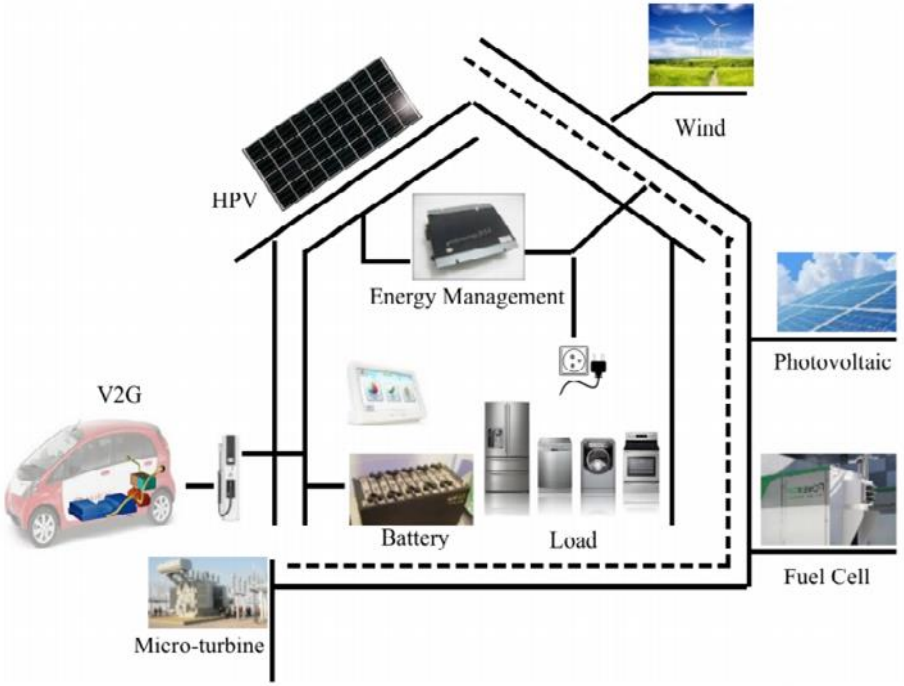
Solar carport module (2019, Patent Application Publication for King Abdulaziz University , Jeddah)

- Talks about the energy production systems relying on PV panels.
- Illustrates several designs and drawings of a solar carport
- Highlights an obstacle that will occurred with solar carport (light obstructing materials)
- Battery bank



Integrated Energy Management of a Plug-in Electric Vehicle in Residential Distribution Systems with Renewables (2017, Lorestani, A., Aghaee, S. S., Gharehpetian, G. B., & Ardehali, M. M.)

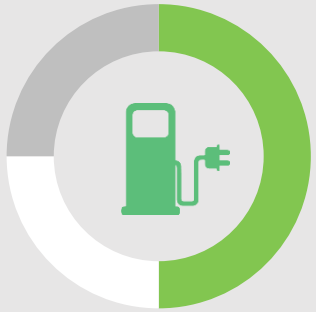
- Illustrates microgirds, residential distribution power systems and renewable systems.
- Plug In Electric Vehicles (PIEV's)
- Uses micro-turbine, active generator PV and wind turbine.
- Storage system for PIEV's
- Home Energy Management System (HEMS)



SUMMARY

Projects	1	2	3	4	Our Project
Solar Carport	✓	✓	✓		✓
EV charging system	✓	✓		✓	✓
Residential Load (Green home)				✓	✓
Local storage system (Battery Bank)	✓	✓	✓	✓	✓
Grid independent	✓			✓	✓

PROJECT PLAN



SUBSYSTEM III

SUBSYSTEM II

SUBSYSTEM I

MAIN SYSTEM

50%

EV CHARGER

- Faced issues with shipments from china

60%

GREEN HOME

- Faced issues with PMU maintenance dept.

100%

BATTERY BANK

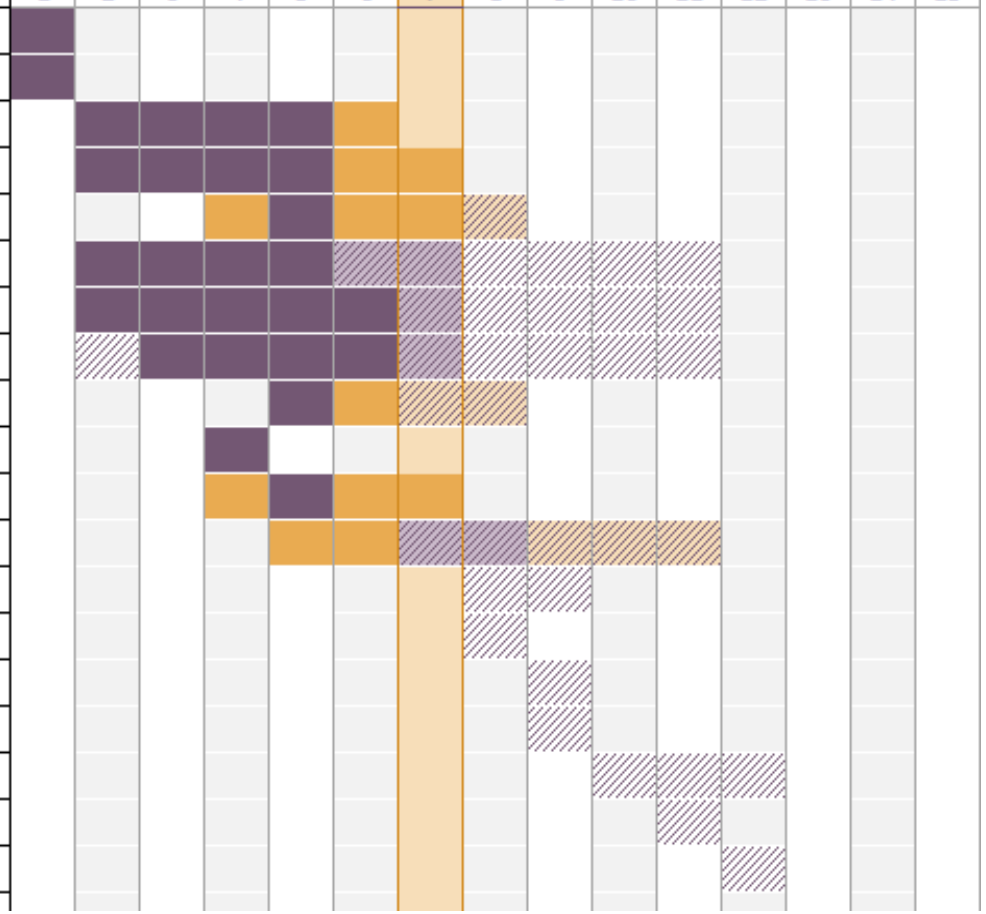
100%

SOLAR CARPORT

Title: SMART SOLAR CARPORT PARKING SYSTEM	Advisor: Mr. Saifullah Shafiq	Design II (ASSE 3)	Spring 2020
Abdullah N. Al-Qahtani 201501245 ' Project Leader (ANQ)		Project PLAN & Progress	
Abdullah M. Al-Ghamdi 201402209 (AMG)		ProgRpt No. 3	
Abdulaziz A. Al-Abdulwahab 201602677 (AAA)		Submission date: March 5, 2020	
Saif F. Al-Sharif 201502262 (SFS)		Instructor: Dr. Sadiq Alhuwaidi	

Period Highlight: 7 — Plan — Actual — Actual (beyond plan) — % Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Learn about DC/DC converters (Power Electronics)	1	1	ANQ	1	1	100%
Learn about EV charging principles	1	1	ALL	1	1	100%
Design subsystem III (EV charger)	2	4	ALL	2	5	100%
Design DC/DC converters (BOOST, XFMR and XFMR-LESS)	2	4	ANQ	2	6	100%
Finalise DC/AC inverter (IGBT implementation)	5	1	ANQ	4	5	80%
Search for components	2	10	AMG	2	6	80%
Procurements	2	10	AMG	2	6	85%
Programing	2	10	SFS	3	5	90%
Test DC/AC inverter	5	1	ALL	5	4	70%
Determine green home loads	4	1	AAA , SFS	4	1	70%
Design green home structure	5	1	AAA	4	4	100%
Structure implementation of subsystem I (Green home)	7	2	AAA , SFS	5	7	30%
Test DC/DC converter	8	2	ANQ , AMG			0%
Install residential loads and test Subsystem I (Green home)	8	1	ALL			0%
Implement and test EV charger	9	1	ALL			0%
Implement the entire project	9	1	ALL			0%
Test the project	10	3	ALL			0%
Prepapre final report	11	1	ANQ			25%
Prepapre final presentation	12	1	ANQ			40%



BUDGET ESTIMATION

Item	Quantity	Unit Price (SAR)	Total (SAR)
Solar Panel 160W	3	300	900
Battery 150Ah, 12V	1	800	800
Charge Controller	1	200	200
Metal and Wood structure	1	2000	2000
Arduino Mega	2	150	150
H- Bridge Rectifier	2	50	100
H Bridge IGBT	1	400	400
DC/DC Converter	1	100	100
DC Voltage Sensor	1	200	200
Ferrite Core Transformer	1	250	250
Current Sensor	2	130	260
Miscellaneous	1	2000	2000
Total			7360

PROGRESS FOR SPRING

DESIGNED DC/DC BOOST CONVERTER

DESIGNED GREEN HOME STRUCTURE

PROCUREMENTS

UPGRADED DC/AC INVERTER CODE

PROCUREMENTS

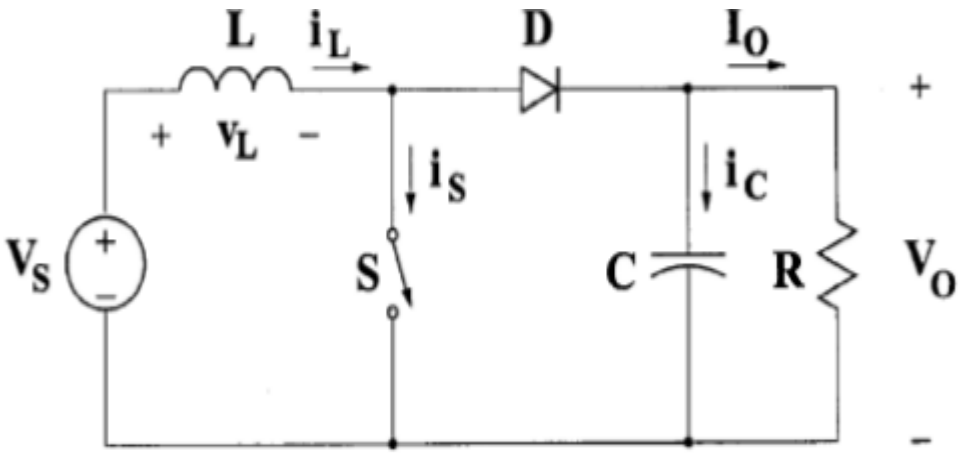
TESTED VOLTAGE AND CURRENT SENSORS

PROCUREMENTS

UPGRADED DC/DC CONVERTER INTO BUCK

COORDINATED WITH MAINTENANCE DEPT. TO IMPLEMENT THE GREEN HOME

(1) DC/DC BOOST CONVERTER



$$C\,max = \frac{DmaxVmax}{VrRmaxf} = \frac{(20.83)(250)}{(1\%)(175)(45k)} = 66.12\,mF$$

$$D\,max = \frac{Vo\,max}{Vs} = \frac{250}{12} = 20.83$$

$$C\,min = \frac{DminVmin}{VrRminf} = \frac{(14.58)(175)}{(1\%)(50)(45k)} = 115.5\,mF$$

$$D\,min = \frac{Vo\,min}{Vs} = \frac{175}{12} = 14.58$$

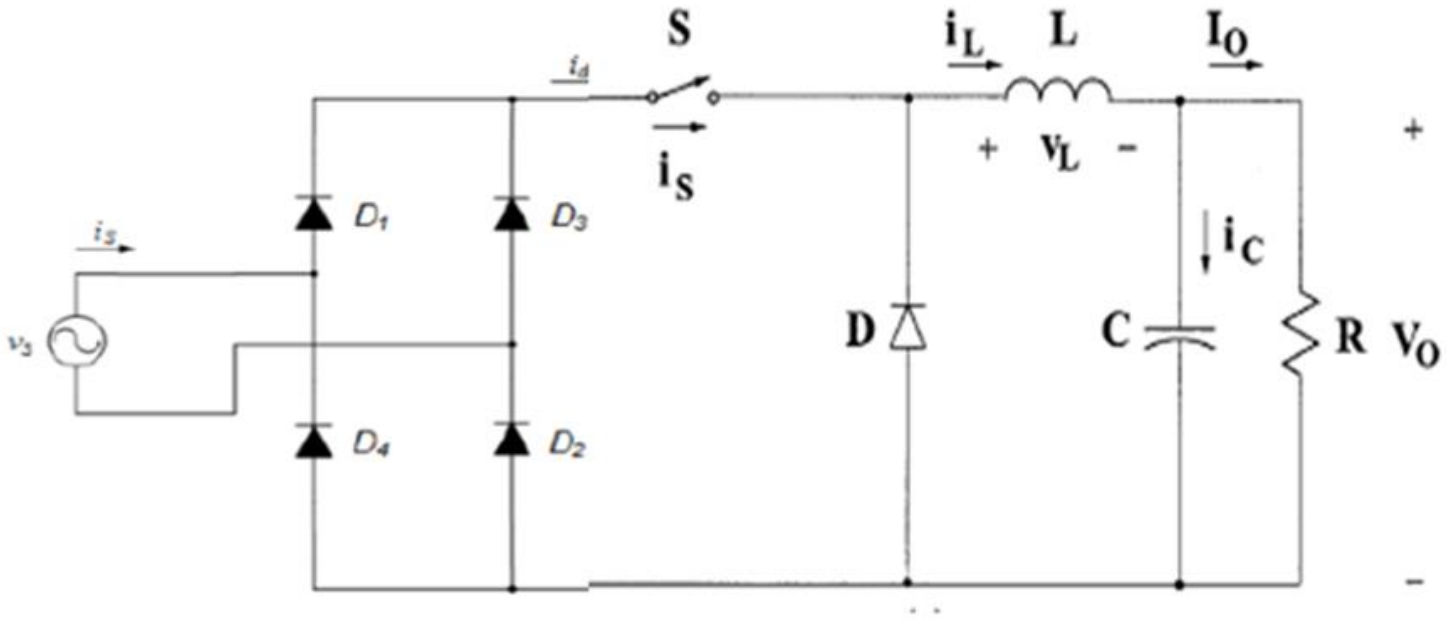
$$L\,max = \frac{(1-Dmax)^2 DmaxRmax}{2f} = \frac{(1-20.83)^2(20.83)(175)}{(2)(45k)} = 15.92\,H$$

$$R\,min = \frac{Vo\,max}{I\,max} = \frac{250}{5} = 50\,\Omega$$

$$L\,min = \frac{(1-Dmin)^2 DminRmin}{2f} = \frac{(1-14.58)^2(14.58)(50)}{(2)(45k)} = 1.55\,H$$

$$R\,max = \frac{Vo\,min}{I\,min} = \frac{175}{1} = 175\,\Omega$$

(2) DC/DC BUCK CONVERTER



$$R = \frac{V}{I}$$

$$L = \frac{(1-D)R}{2f}$$

$$C = \frac{(1-D)Vo}{8VrLf2}$$

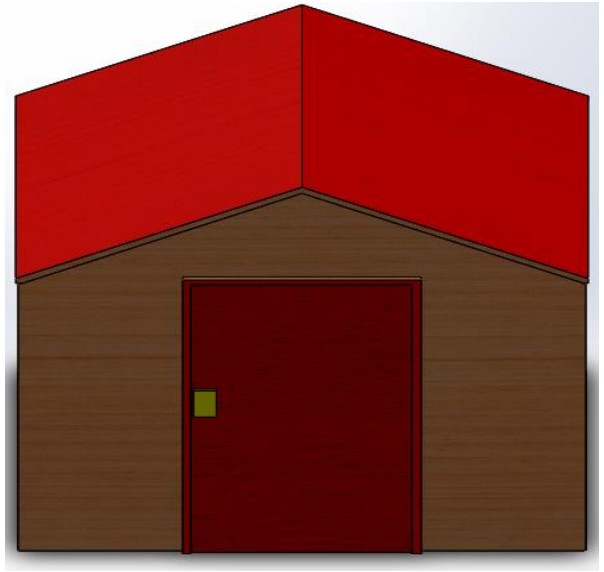
$$R = \frac{220}{5} = 44\ \Omega$$

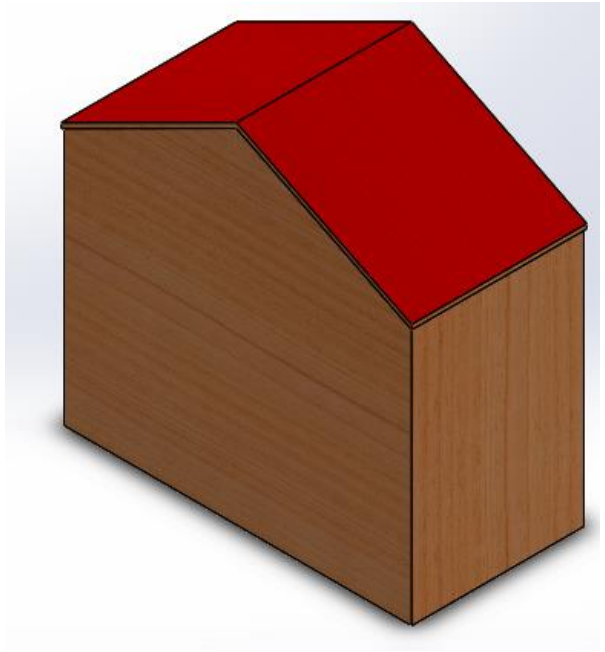
$$D = \frac{Vo}{Vs} = \frac{220}{320} = 0.6875$$

$$L = \frac{(1-D)R}{2f} = \frac{(1-0.6875)*44}{2*45k} = 0.3\ mH$$

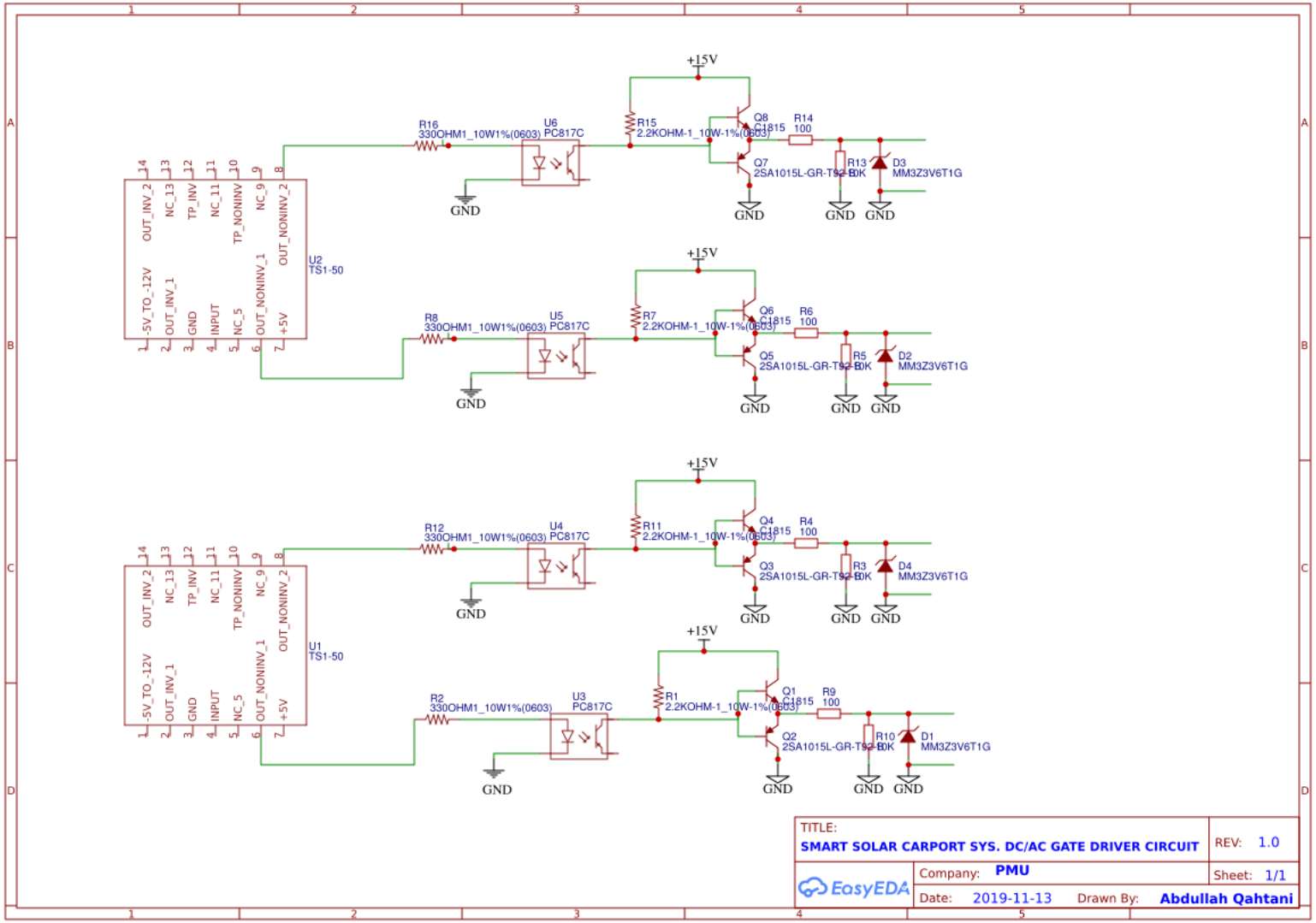
$$C = \frac{(1-D)Vo}{8VrLf2} = \frac{(1-0.6875)*220}{(8)(1\%)(0.3m)(45k)(45k)} = 1.414\ mF$$

SUBSYSTEM III:GREEN HOME DESIGN





SUBSYSTEM I: DC/AC INVERTER



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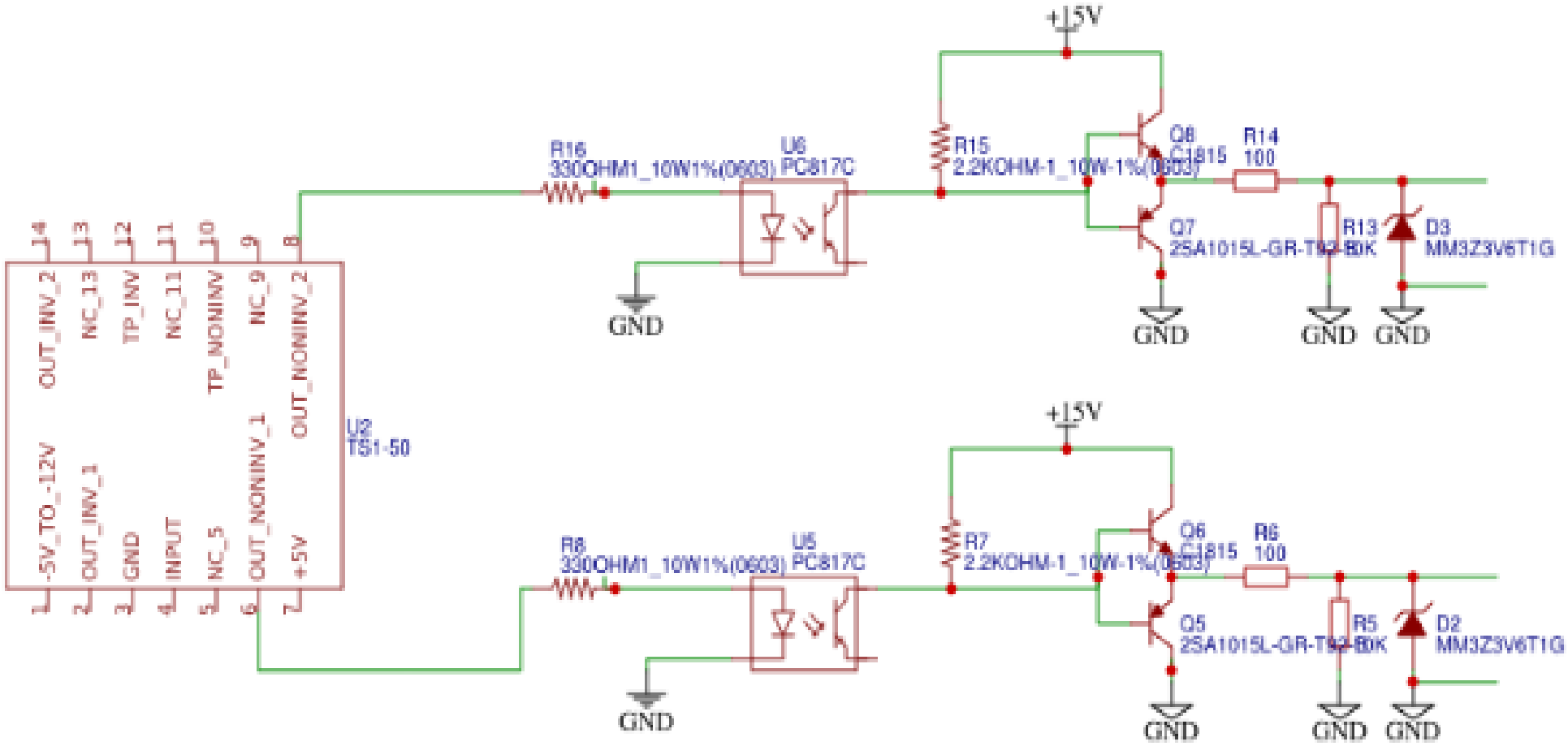

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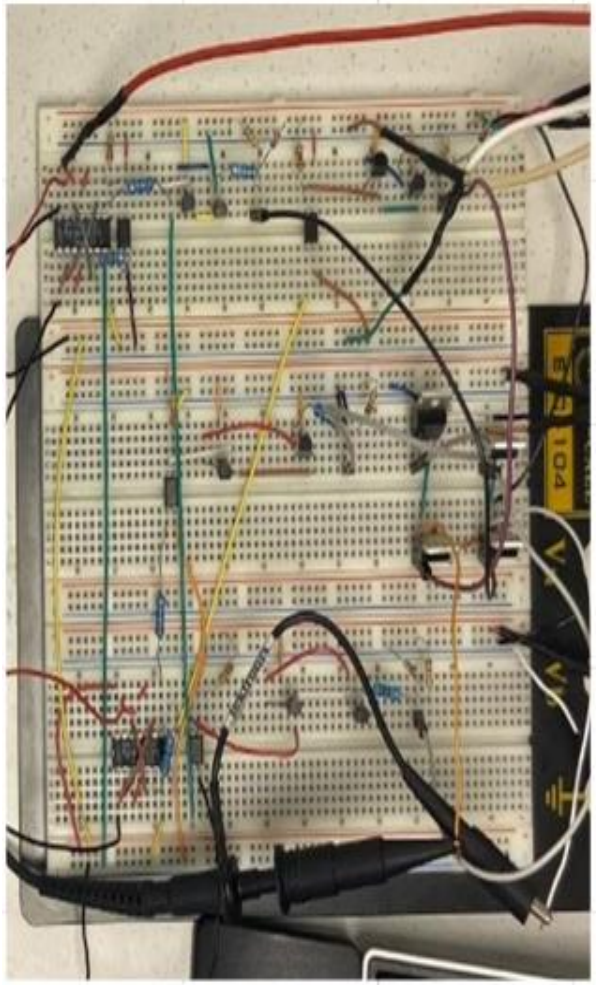
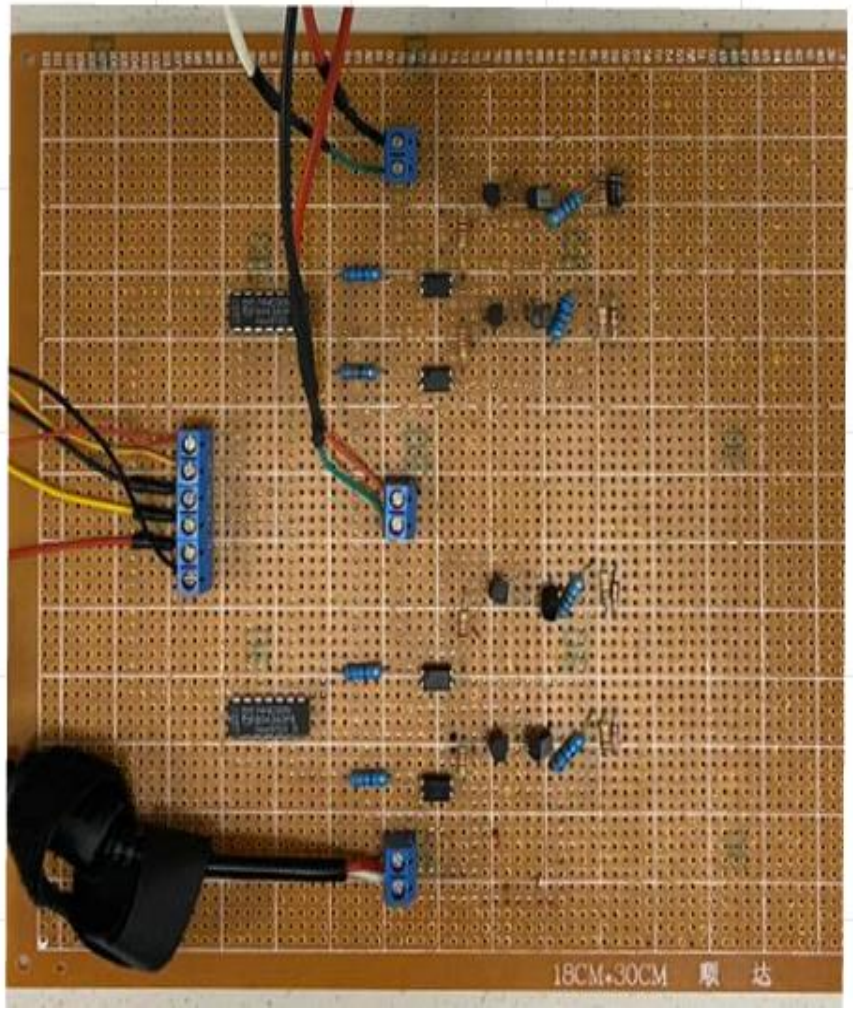
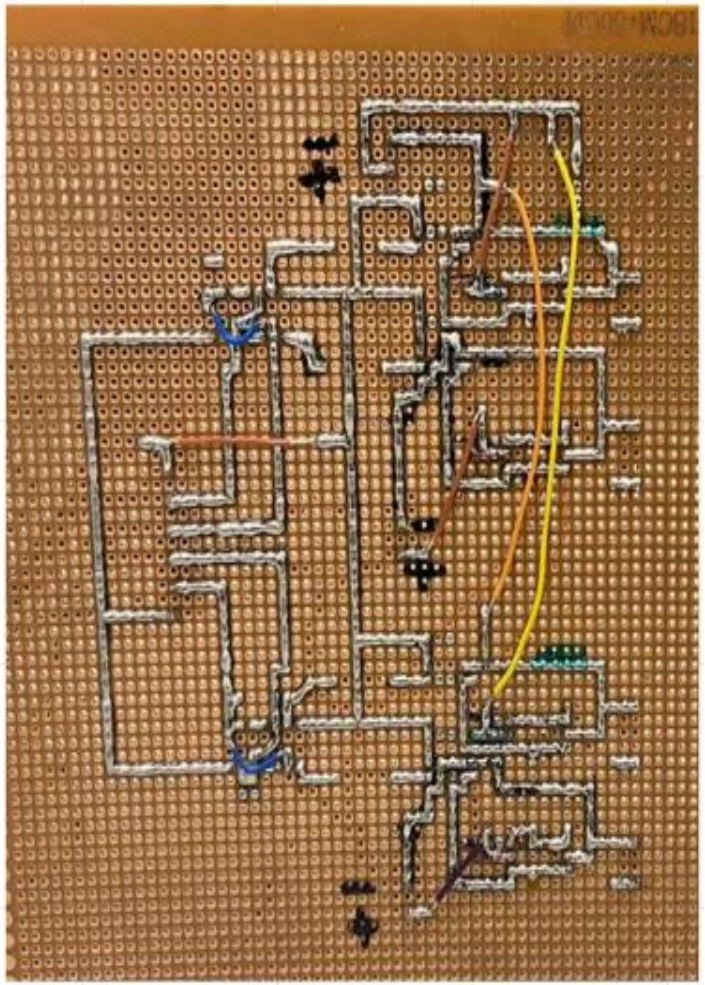
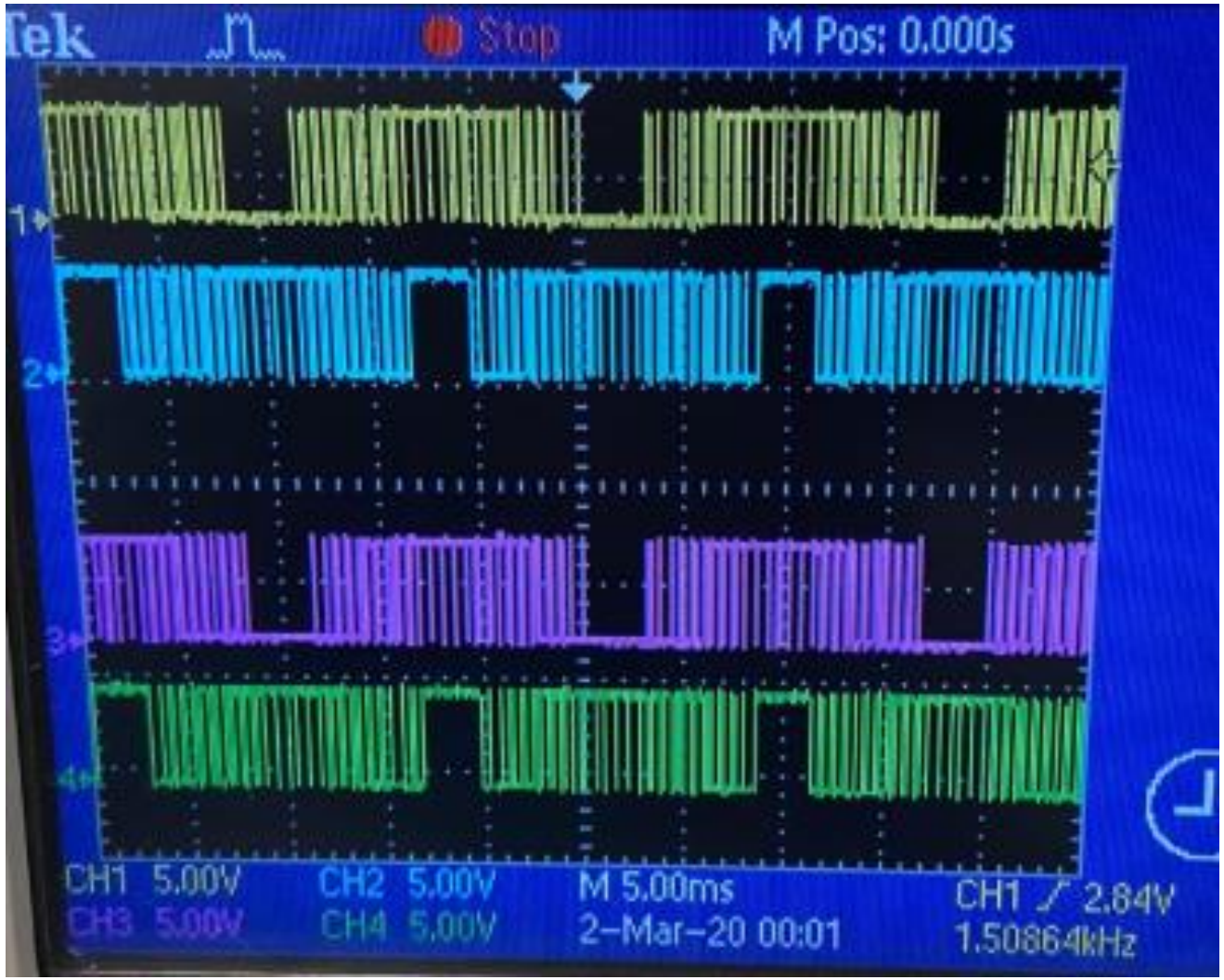


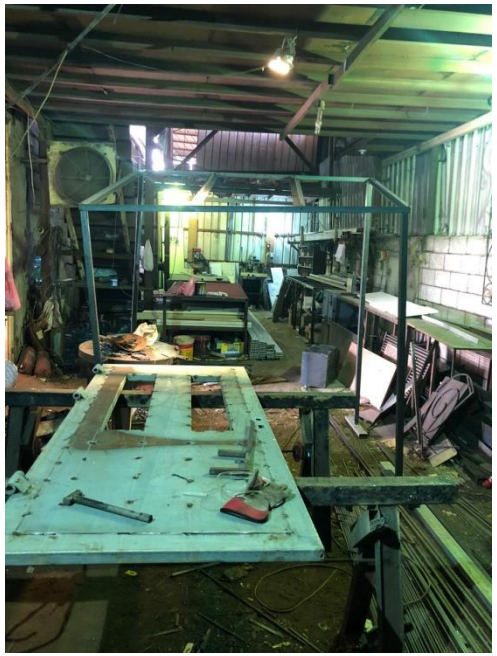


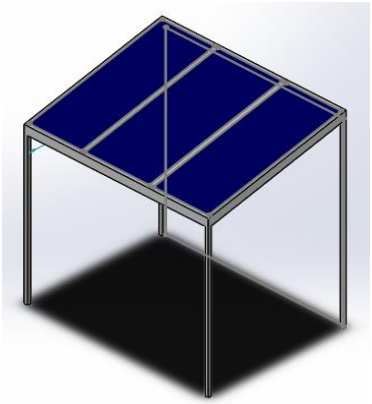


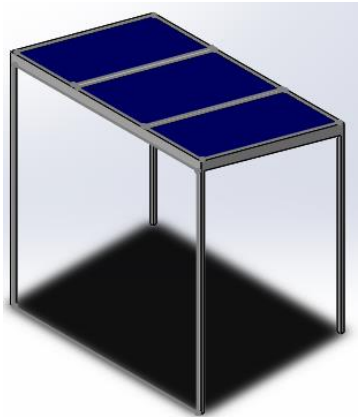
SUBSYSTEM I: DC/AC INVERTER

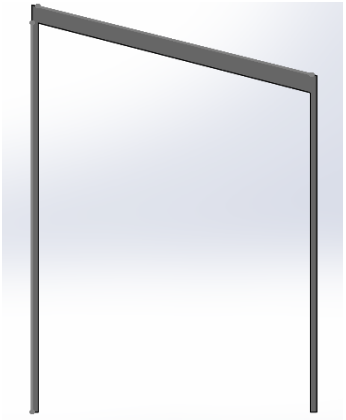


SOLAR CARPORT









SMART SOLAR CARPORT

COMPONENTS

Component	Specifications	Selection Reason
IGBT	SK 25 GH 12T4 VCES 1200 V IC 25 A	The IGBT is H Bridge and it has HIGHER current and power rating
DC/DC Converter	12 to 220V DC high adjustable output voltage voltage boost converter, 70W rating	To boost the battery voltage DC before the inverter circuit.

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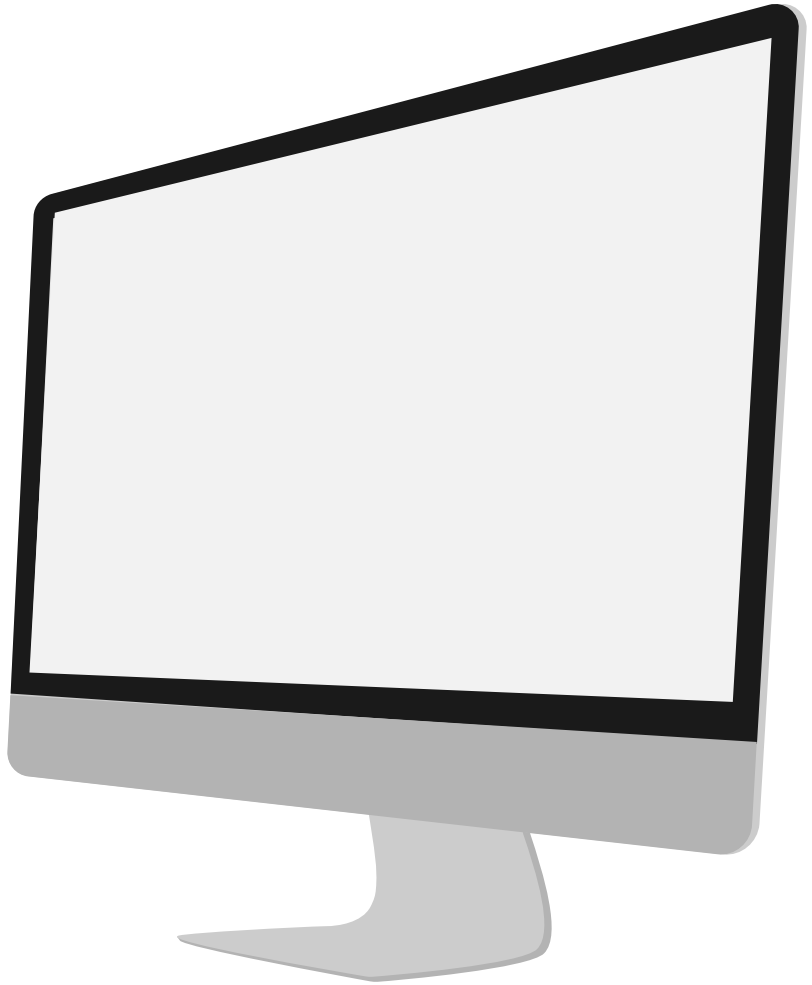
PROGRESS VIDEO



THANK YOU

SMART SOLAR CARPORT PARKING SYSTEM