جامعة الأمير محمد بن فهد الأهلية
PRINCE MOHAMMAD BIN FAHD UNIVERSITY

Design Optimization of Micro-inverter Based AC Photovoltaic Module

Presenting by:	ID:
• Emad Yahya	201601149
• Bassam Alkhunaizi	201501307
• Mohammed Al Najem	201501496
• Ahmad Alhawsawi	201401247

Project Advisors: Dr. Ala Raef Al-Haj Hussein

April 21, 2021

Outline

- Project definition
- Project Objectives
- Project Specifications
- Project Constraints and Engineering Standards
- Project Architecture
- Project Management & Team Work
- Design
- Impact of Project
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- Impact of Project
- Budget Estimate
- References
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- References

Project Definition

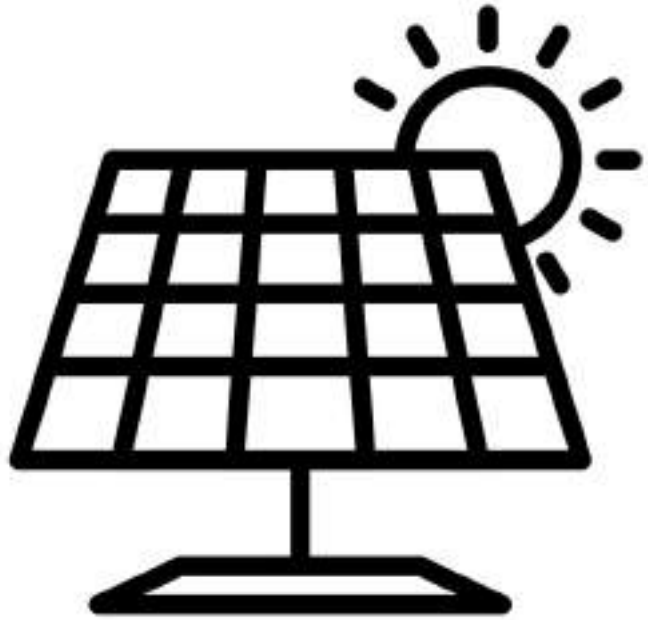
This project aims at designing a 60-W Integrated AC Photovoltaic (PV) module with the power electronic circuits, components and battery storage integrated and mounted on the back of the PV module. The output of the module is a smooth 220V (rms), 60 Hz AC output.

Project Objectives

- Selecting the proper size and type for the solar panels, converter, and inverter that will result in maximum performance and cost-efficiency.
- Integrating all the components in one module.
- Developing a smart MPPT (Maximum power point tracking) to maximize the output power.

Project Specifications

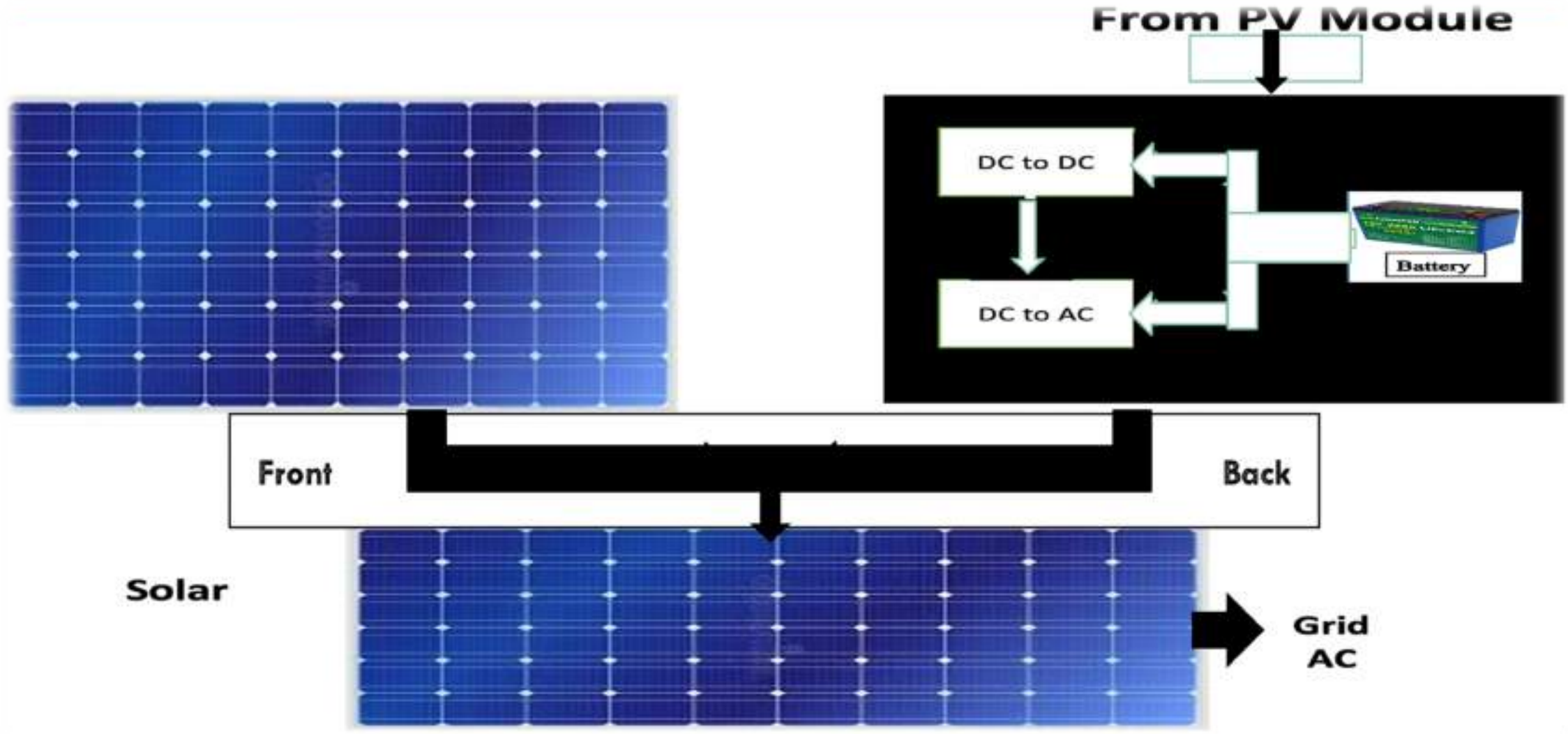
- 220V (rms), 60 Hz AC output.
- Design a micro inverter ac photovoltaic module.
- Work in day time.
- Adaptive Variable Step-size MPPT (maximum power point tracking) algorithm that increases the accuracy and speed.
- Specs of the converter 600 W, inverter 500 W, PV module 60 W.



Design Constraints
&
Standards

BUDGET ENVIRONMENT

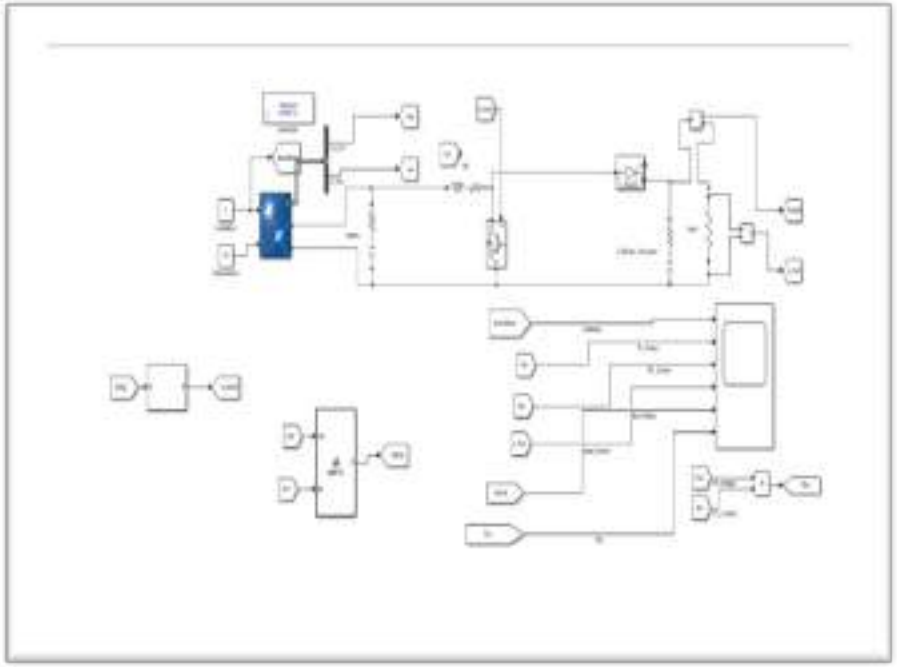
Project Architecture



Subsystems Architecture

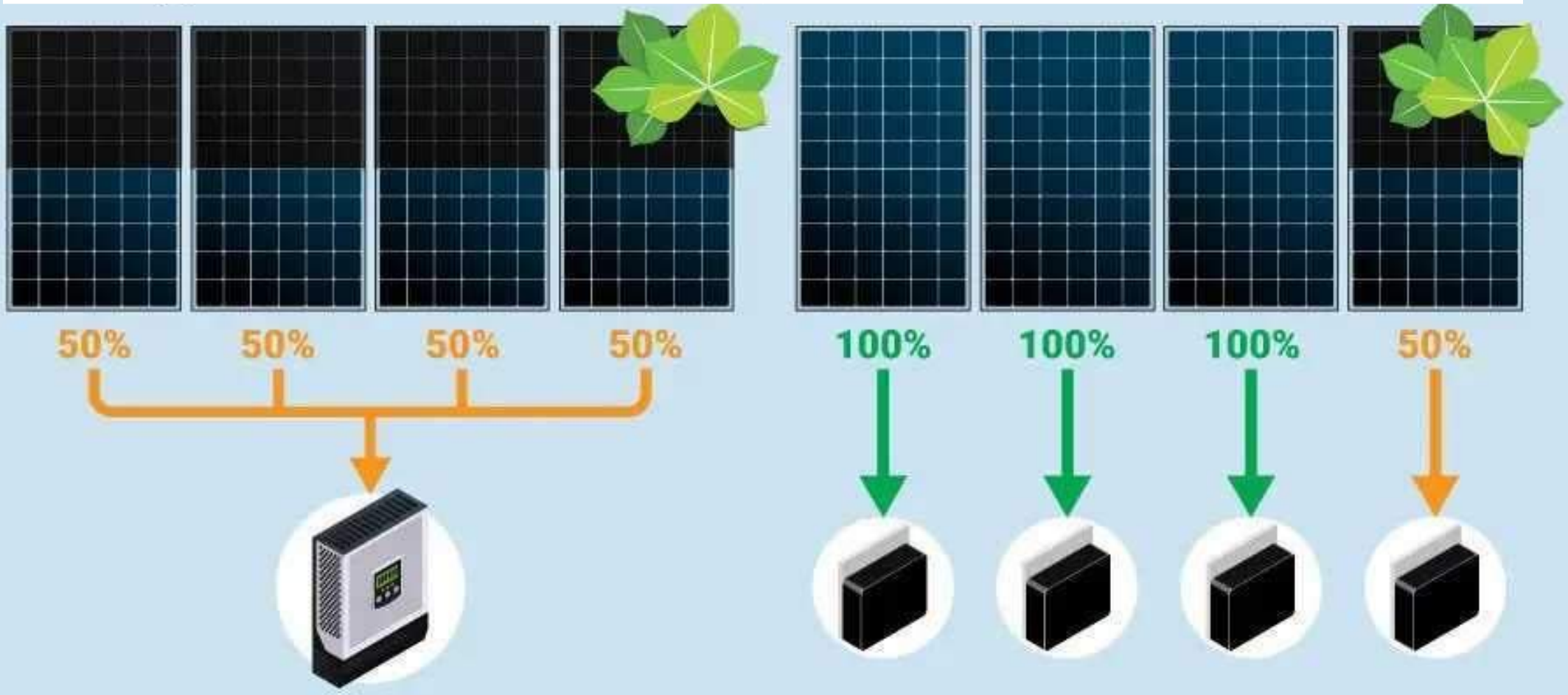
Subsystem 1 (Hardware)

Subsystem 2 (Software)



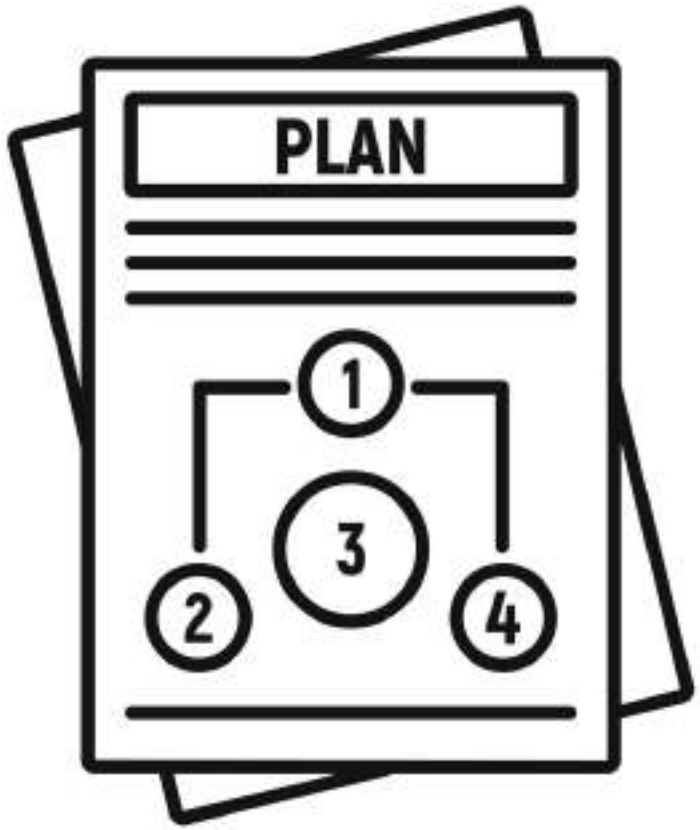
Inverter/ Components	Micro-Inverter	String-Inverter	Centralized-Inverter
Solar Panel	4	4	4
Converter	4	2	1
Inverter	4	2	1

Centralized-Inverter & String-Inverter	Micro-Inverter



Planning

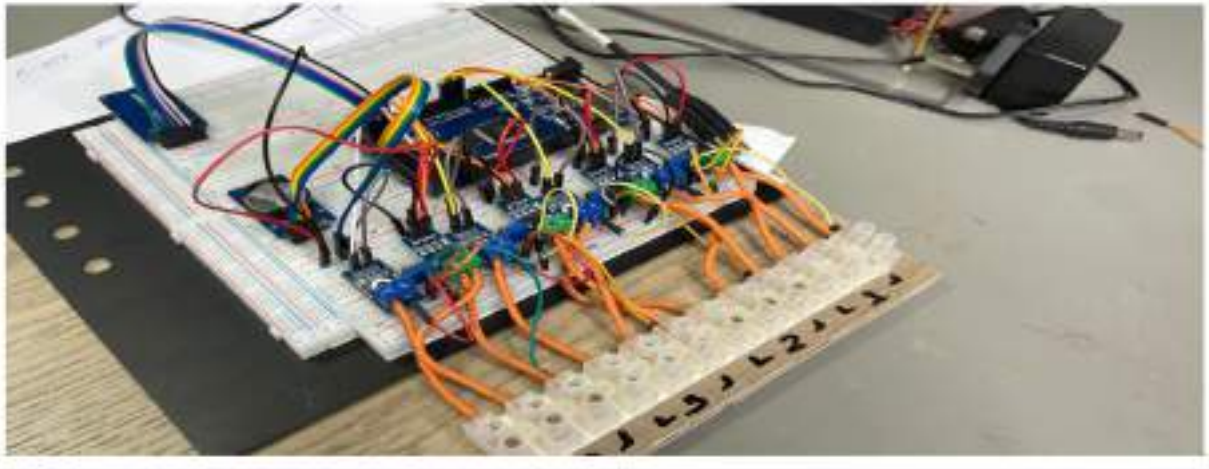
- Our project is easy to use
- All our components are available in local market
- We did all the tests at PMU labs



Completed Work

- Write a plan
- We bought all the components
- We build and tests the prototype
- Subsystem 1
- Architectures
- Simulate the project
- Check the project results
- Subsystem 2
- Finalized the design
- Prepare final report
- Prepare project demo

DESIGN

Solar Panel 60 W	Data Logger
	
Converter 600 W	**Inverter 500 W**
	

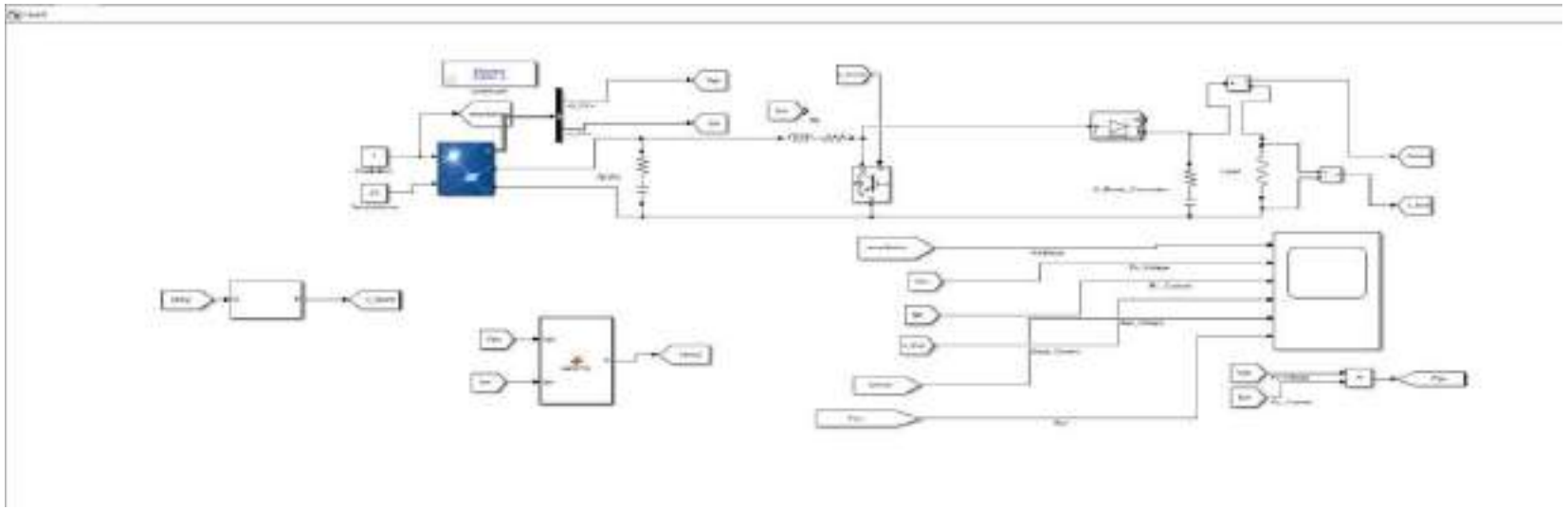
SUBSYSTEM 1

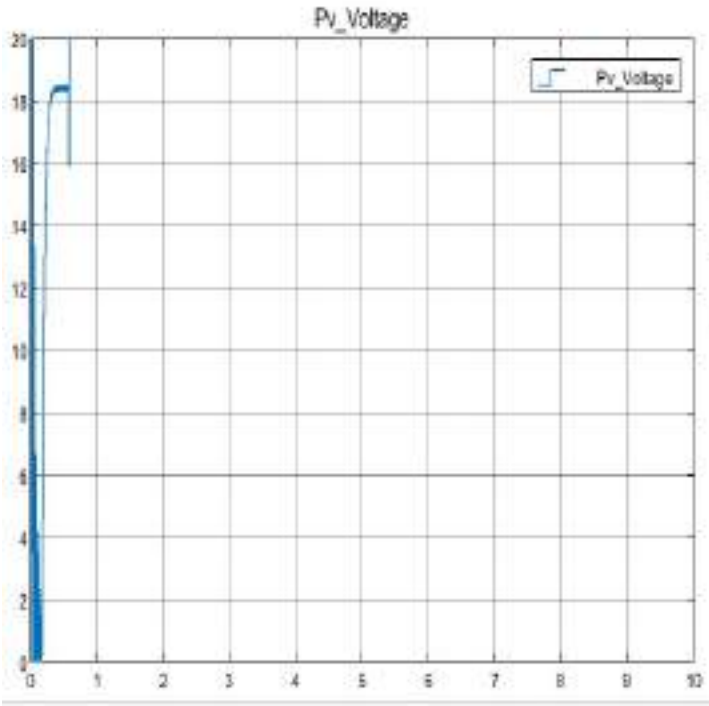


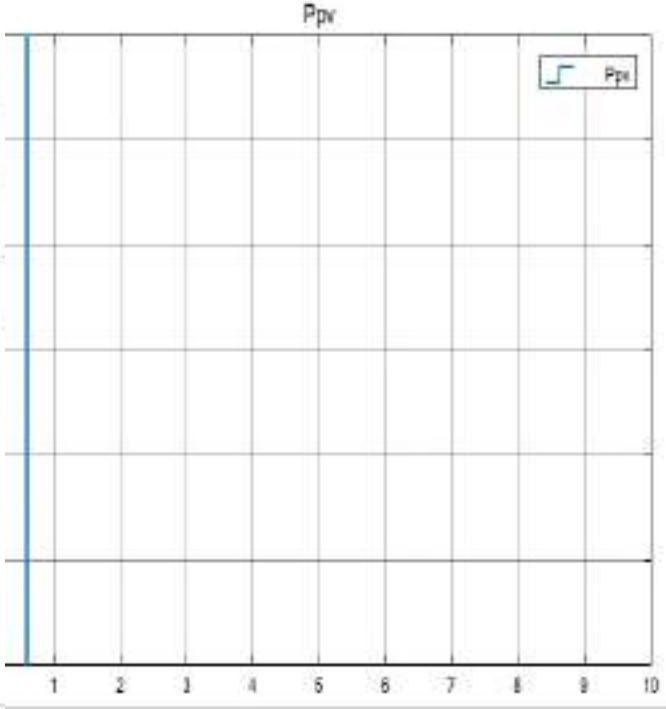


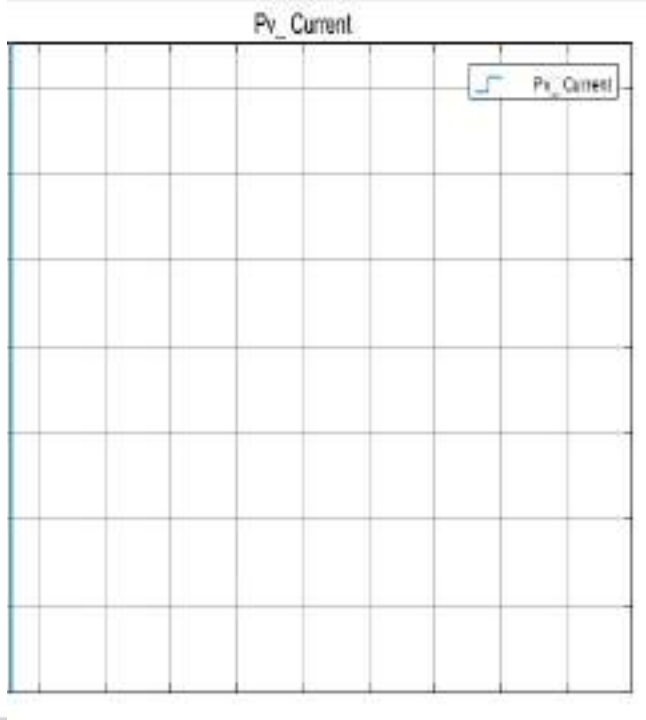

SUBSYSTEM 2

```
function D = MPPT2(Vpv,Ipv)
persistent Dprev Pprev Vprev
if isempty(Dprev)
    Dprev=0.7;
    Vprev=190;
    Pprev=2000;
end
deltaD=0.001;
Ppv = Vpv*Ipv;
if(Ppv-Pprev)~=0
    if(Ppv-Pprev)>0
        if(Vpv-Vprev)>0
            D=Dprev-deltaD;
        else
            D=Dprev+deltaD;
        end
    else
        if(Vpv-Vprev)>0
            D=Dprev+deltaD;
        else
            D=Dprev-deltaD;
        end
    end
else
    D=Dprev;
end
Dprev=D;
Vprev=Vpv;
Pprev=Ppv;
```

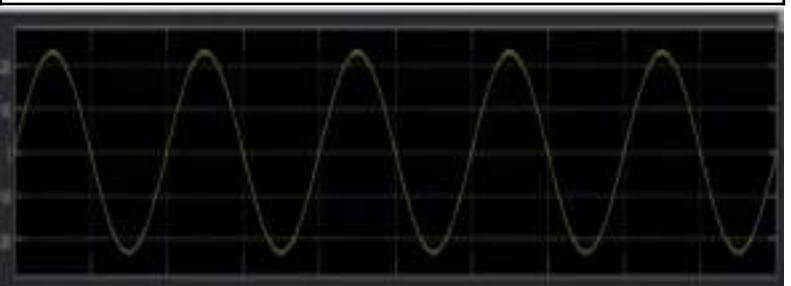
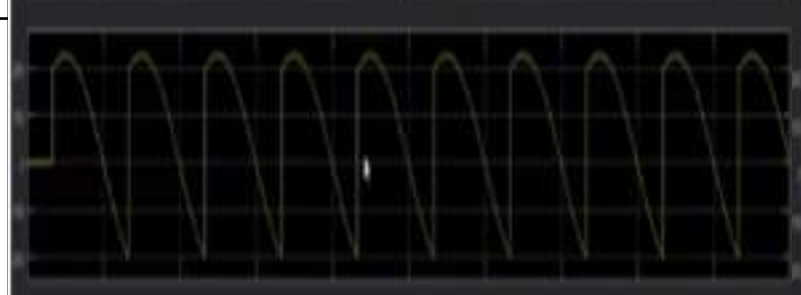








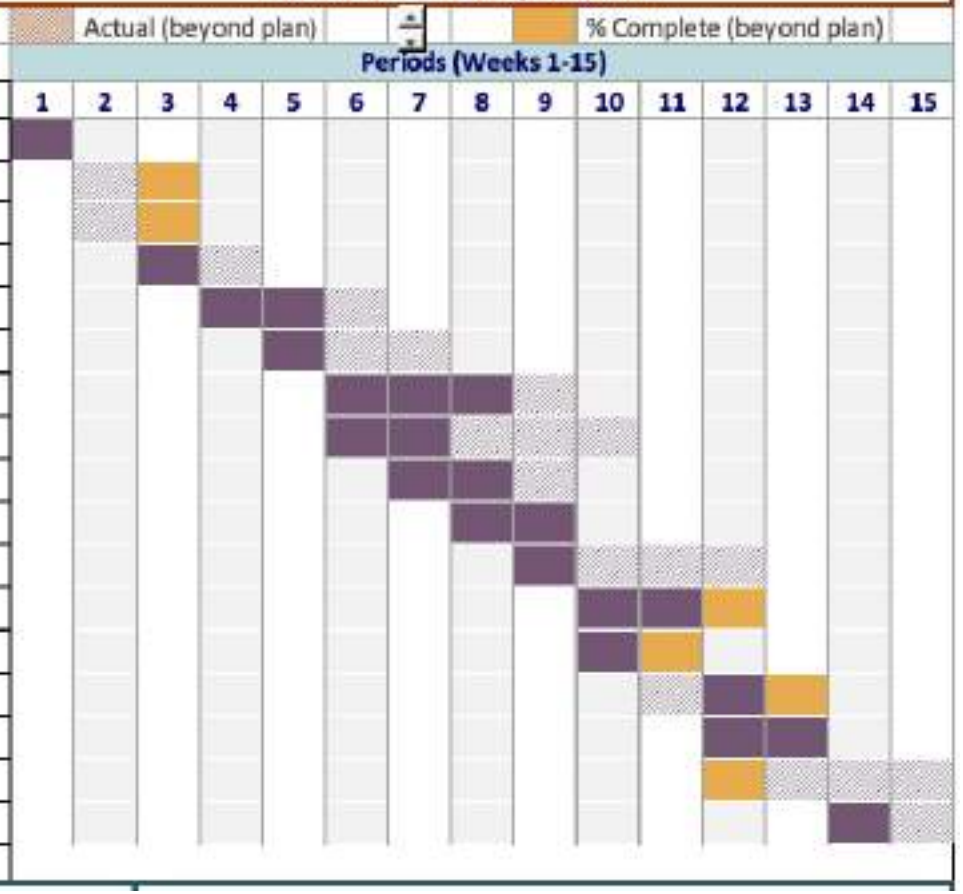
Simulations

	Micro-Inverter	String-Inverter	Centralized-Inverter
Sine Wave			
Frequency			
Source Wave			

Project Management & Team Work

Title: Design Optimization of Micro-inverter Based AC Photovoltaic Module	Advisor: Dr. Ala Raef Al-Haj Hussein	Design II (ASSE 3)	Spring 2021
Emad Yahya 201601149 (EY) 201601149		Project PLAN & Progress	
Bassam Alkhunaizi (BA) 201501307		ProgRpt No. 5	
Ahmed Alhawsawi (AA) 201401247		Plan updated (Date): APR. 17, 2021	
Mohammed Al Najem (MA) 201501496		Instructor: Dr. Sadiq Alhuwaidi	

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Write a plan	1	1	ALL	1	1	100%
Build the prototype	2	1	ALL	3	1	100%
Test the prototype	2	1	ALL	3	1	100%
Buy all the components	3	2	EY, AA	3	1	100%
Subsystem 1	4	3	MA, BA	4	2	100%
Architecture 1&2&3	5	3	MA, AA	5	1	100%
Design the structure	6	4	BA, EY	6	3	100%
Simulate the project using simlink	6	5	AA	6	2	100%
Prepare midterm presentation and video	7	3	EY	7	2	100%
Check the project results	8	2	ALL	8	2	100%
Design the project	9	4	ALL	9	1	100%
Subsystem 2	10	2	BA, AA	10	3	100%
finalized the design	10	1	MA, EY	10	2	100%
Prepapre final report	11	2	ALL	12	2	100%
Prepapre final presentation	12	2	BA	12	2	100%
Prepare project demo	13	3	ALL	12	1	100%
Submit Rpt/PPT/Brochure/Video...etc.	14	2	MA, AA	14	1	100%



Project Management & Team Work

Task	Emad	Bassam	Mohammad	Ahmed
Search & acquire components	30%	20%	10%	40%
Design	10%	30%	40%	20%
Testing	20%	40%	30%	10%
Write Reports & Presentations	40%	10%	20%	30%

- **Challenges**

1. COVID-19
2. IMPLEMENTATION
3. SIMULATION THE PROJECT

Risk Assessment and Management

#	Risk Description	Risk Management	Impact
1	We don’t have knowledge about the micro-inviter photovoltaic module	We can’t do the project	We have learned what it is with help with Dr. Ala
2	We don’t have any knowledge of MPPT	We will lose time and we won’t be able to finish subsystem 2	We have learned what is MPPT with help with Dr. Ala
3	We haven’t used MATLAB Simulink before	It cost effectively to project and cost us time	We have learned how to use it by watching YouTube videos explain how to use it

New Skills Acquired and Applied

- Analyzed data using Excel
- Get AC from solar panel
- MATLAB Simulink

Impact of project

- MONEY
- SPACE
- TIME

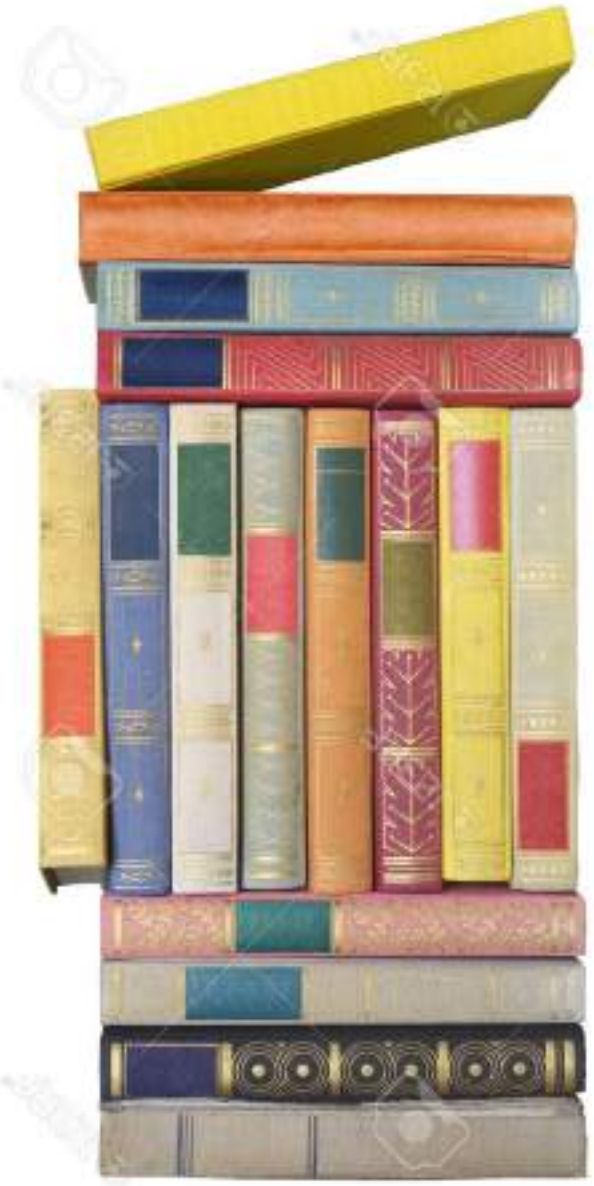
PROJECT COST

No.	Description	Quantity	Unit Cost (SR)	Total Cost (SR)
1	SOLAR PANEL	4	180	720
2	INVERTER	4	280	1120
3	CONVERTER	4	90	360
4	BATTERY	1	0	0
5	SENSORS	10	8	80
Totals				2280 SR

Video

References

- 1. Wills, R.H., et. al, *The AC photovoltaic module concept.* IEEE Energy Conversion Engineering Conference, 1997.
- 2. Barkhordarian, V., *Power MOSFET Basics.* International Rectifier Application Note, 2005.
- 3. N. Henze, A.E., and P. Zacharias, *"Photovoltaic module with integrated power conversion and inter-connection system the European project pv-mips.* in Proc. 21st European Photovoltaic Solar Energy Conference and Exhibition,Dresden, Germany, 2006.
- 4. F Cheng, S.W., J Hawkins, B Arellano, Lavrova, A Mammoli, Energyt ech, *Applying battery energy storage to enhance the benefits of photovoltaics.* IEEE, 2012.
- 5. J. Flicker, R.K., B. Yang, M. Marinella, and J. Granata, *Insulated gate bipolar transistor reliability testing protocol for PV inverter applications.* 2014.
- 6. S. Kouro, J.I.L., D. Vinnikov, and L. G. Franquelo, *Grid-connected photovoltaic systems: An overview of recent research and emerging PV converter technology.* IEEE, 2015.
- 7. Design of a Grid-Tie Photovoltaic System With a Controlled Total Harmonic Distortion and Tri Maximum Power Point Tracking Ala A. Hussein *, Senior Member, IEEE*, Xi Chen *, Student Member, IEEE*, Mahmood Alharbi , Anirudh Ashok Pise, and Issa Batarseh *, Fellow, IEEE* Controlled Total Harmonic Distortion and Tri Maximum Power Point Tracking Ala A. Hussein *, Senior Member, IEEE*, Xi Chen *, Student Member, IEEE*, Mahmood Alharbi , Anirudh Ashok Pise, and Issa Batarseh *, Fellow, IEEE, 2020.*




Thank
You