Winter 2020
Capstone Final
Presentation
Date: March 30,2020

Solar PV + Lithium Ion Energy Storage System

Winter 2020

Agenda

01 Group Members

02 Problem Statement
Existing Solutions
Objectives

03 Engineering Design & Analysis

04 Product Testing

05 Conclusion

Meet Our Team

Rizwan Khan

Umer Hussain

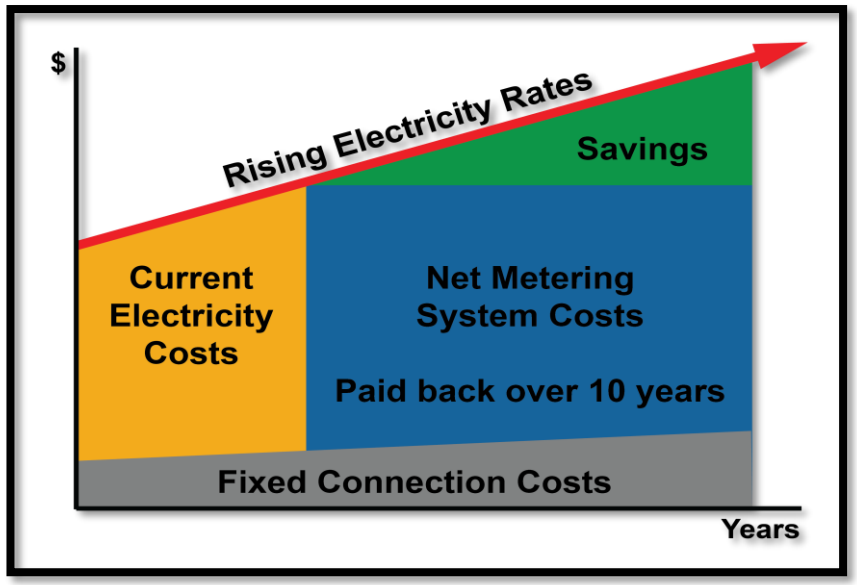
Thisaru Sibera

Uzair Azam

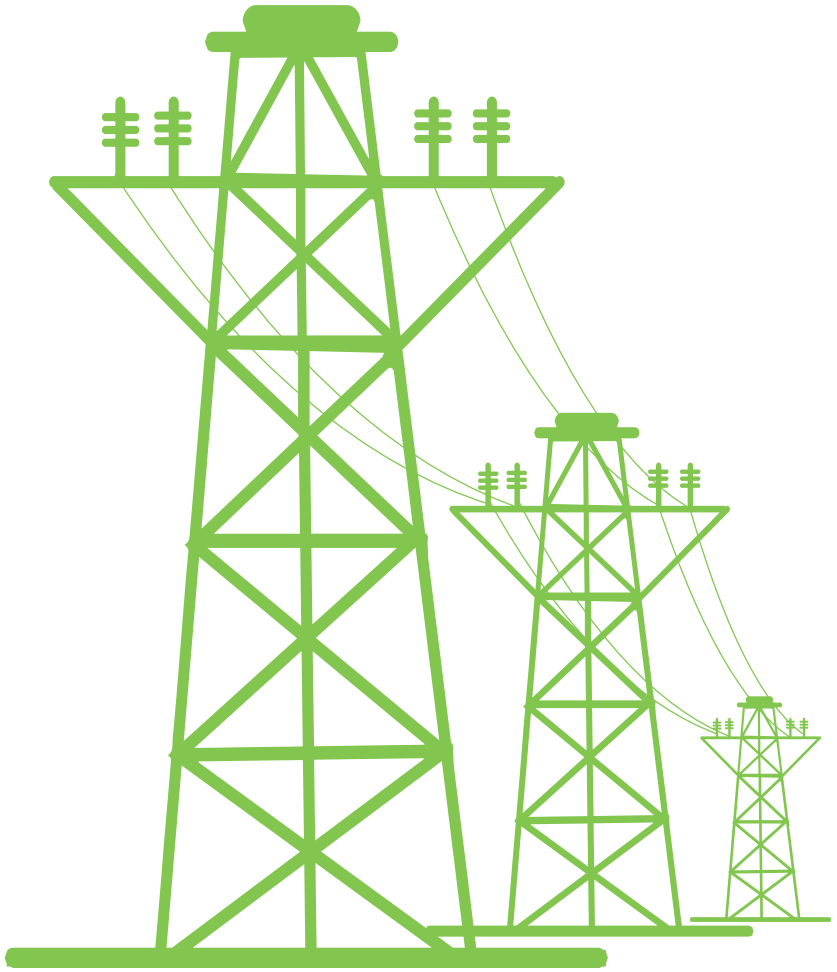
Kevin Patel

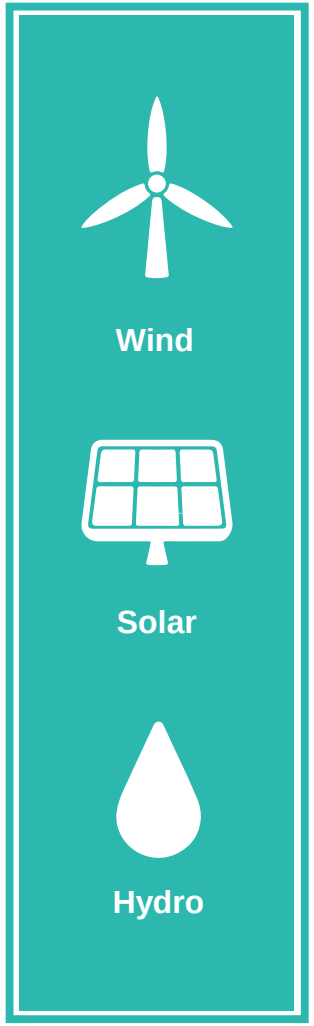
Problem Statement

- Consumers want to spend less on electricity
- Canadian's need to reduce their carbon footprints

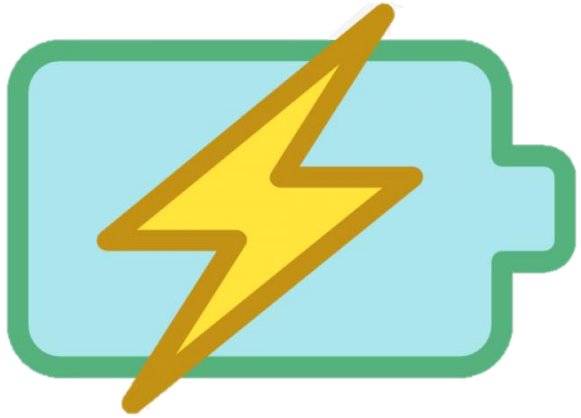


Existing Solutions



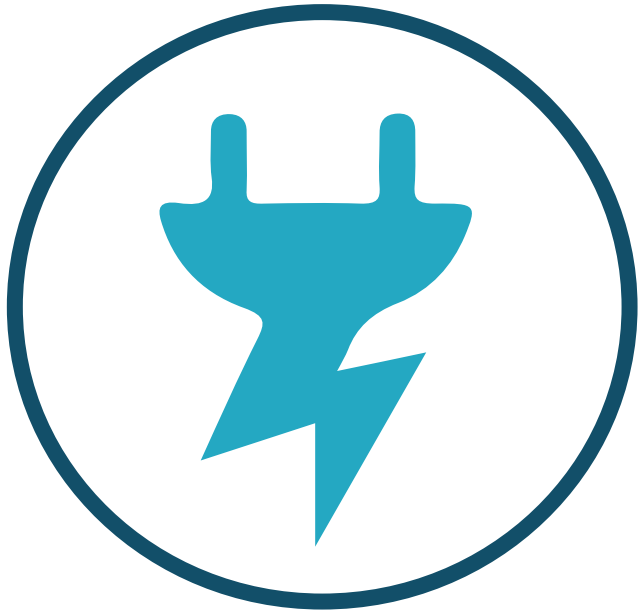


- Solar Energy makes the most sense for a residential application to supply power straight to consumers



Project Objectives

Increase Reliability



Decrease Utility Dependability

Increase Savings

Engineering Design

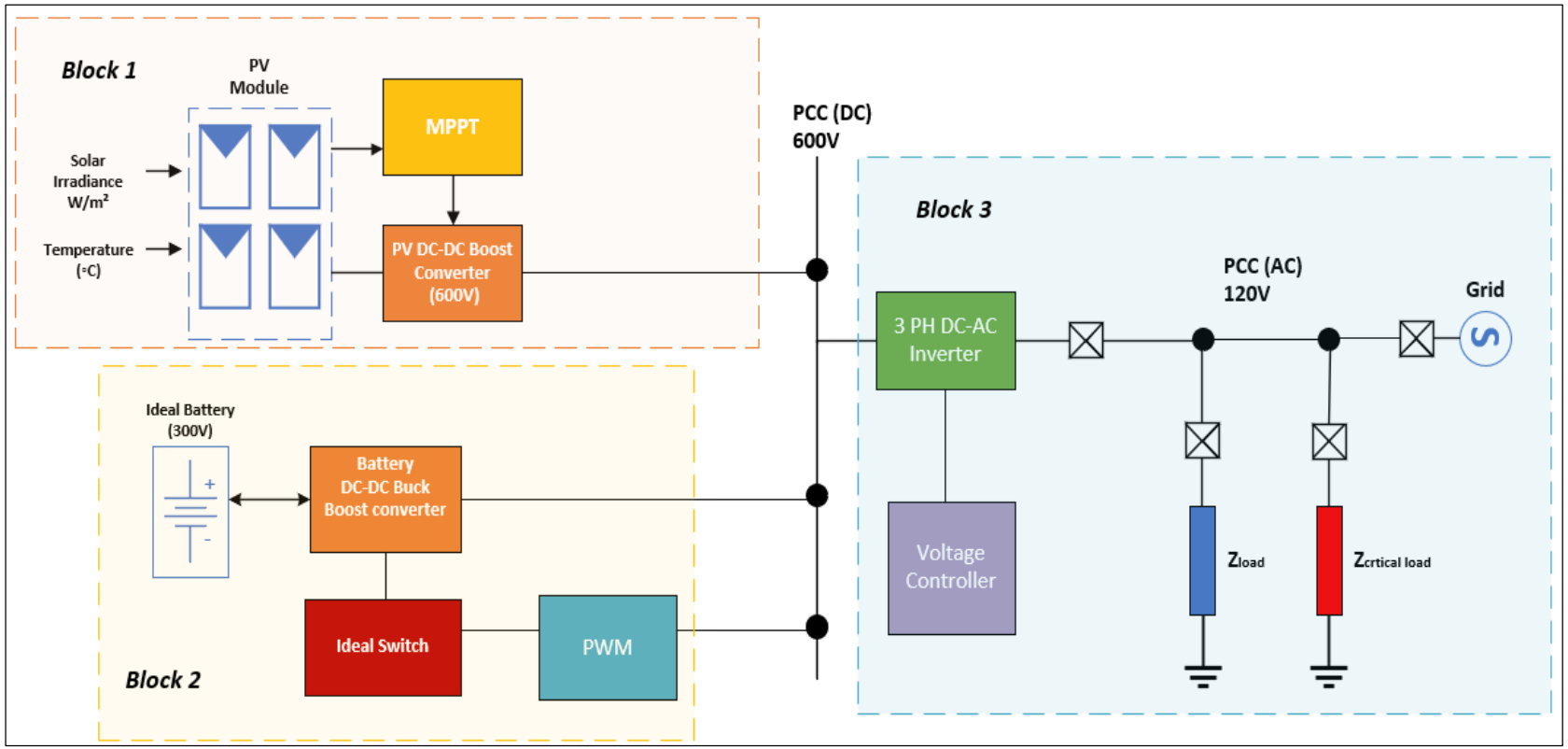


FIGURE 1: HIGH LEVEL-BLOCK DIAGRAM

Simulink Simulation

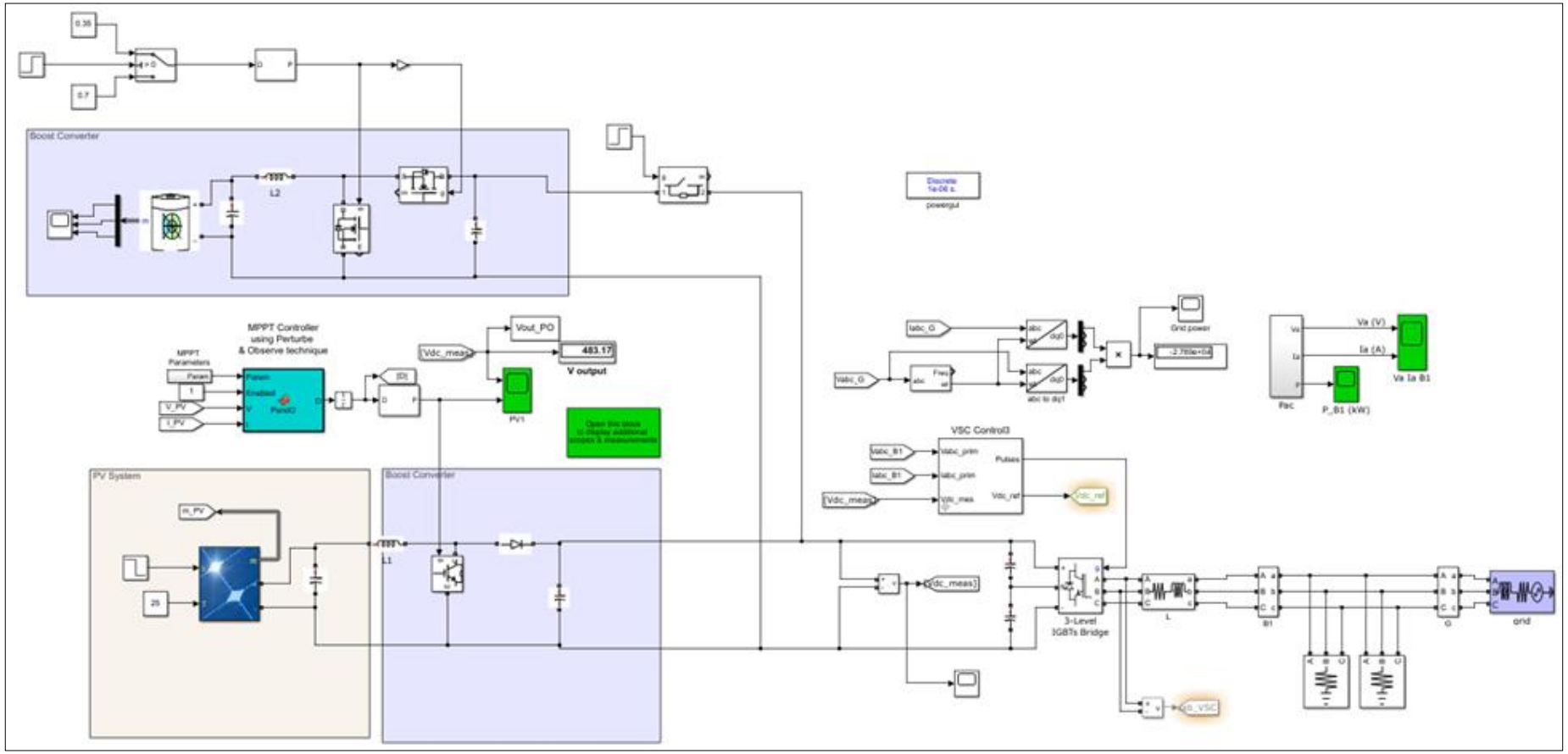


FIGURE 2: SIMULINK SIMULATION OF PV AND ENERGY STORAGE SYSTEM

Design Breakdown

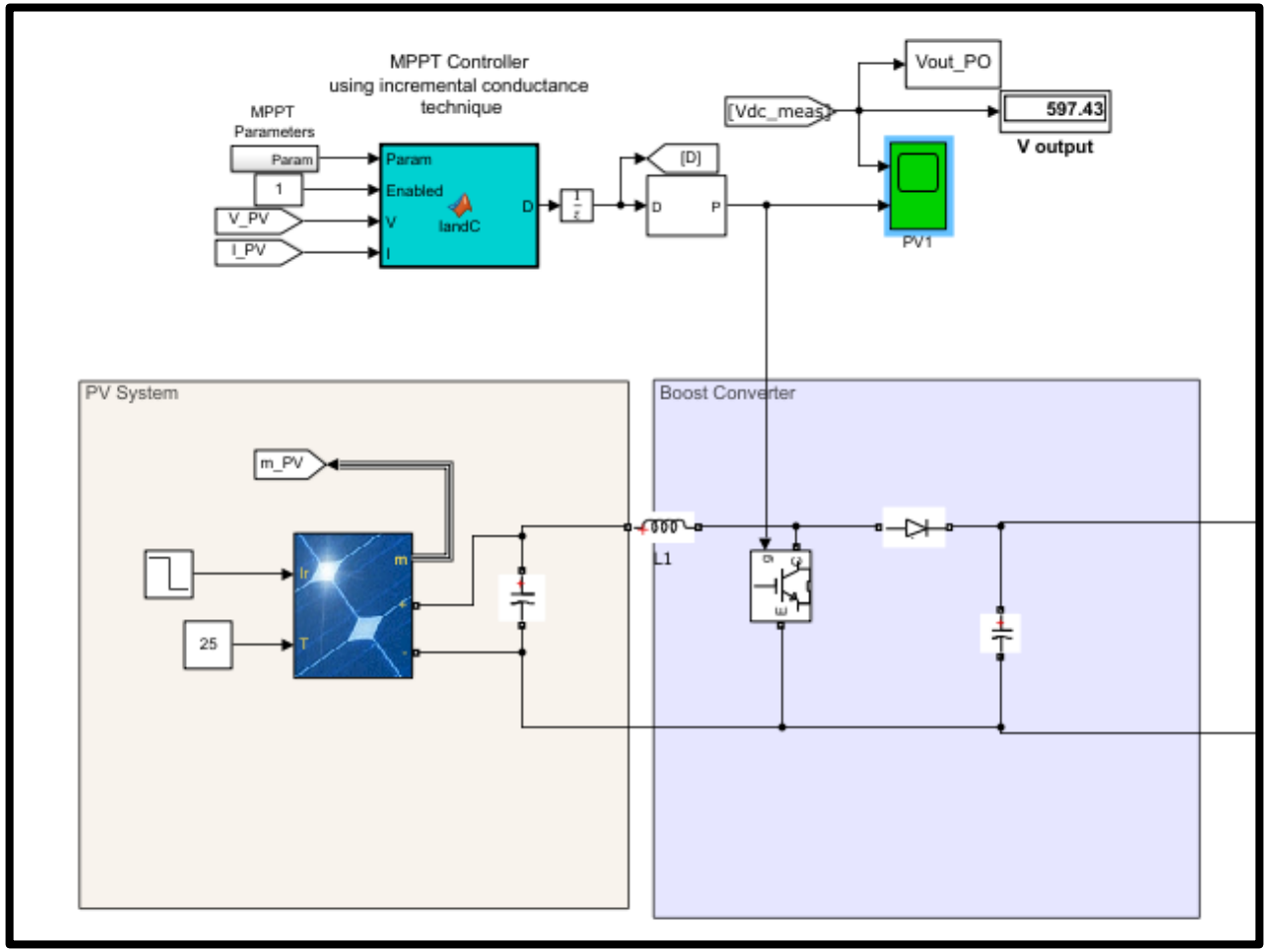


FIGURE 3: BLOCK 1 PV SYSTEM WITH MPPT AND BOOST CONVERTOR

Algorithm 1- Perturb & Observe (P&O)

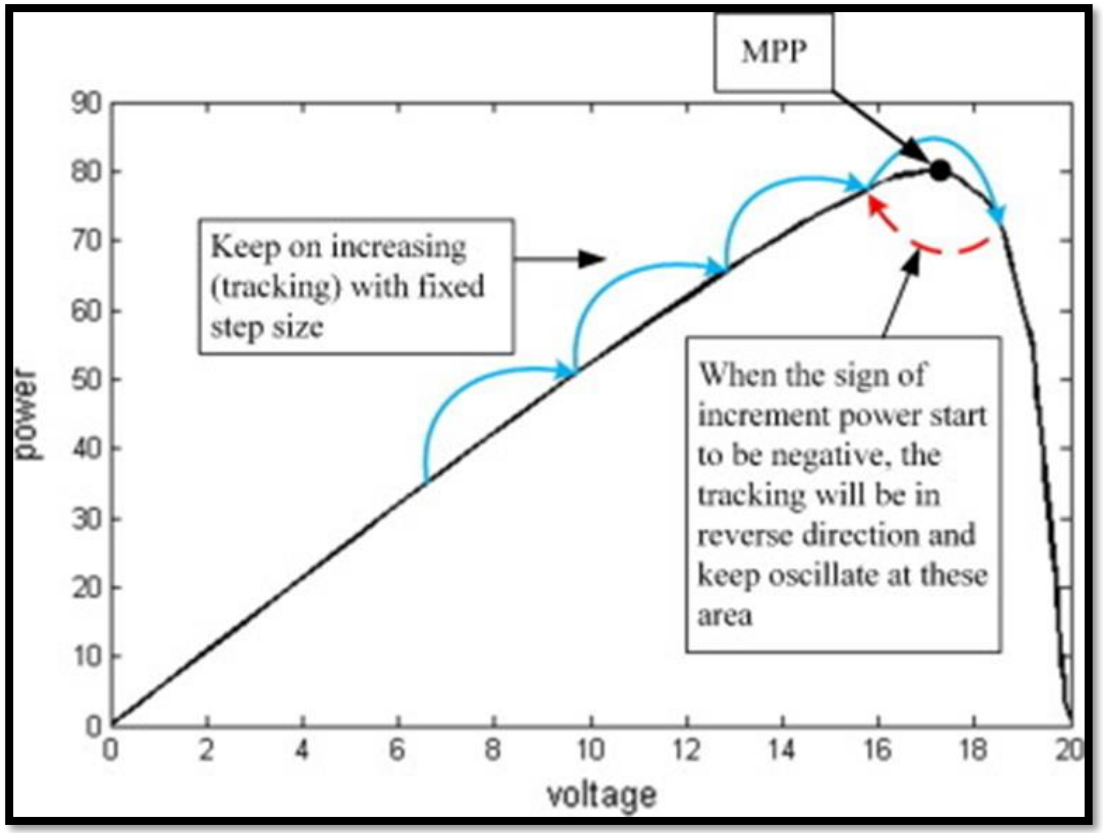


Figure 3: PV Curve using P&O Algorithm

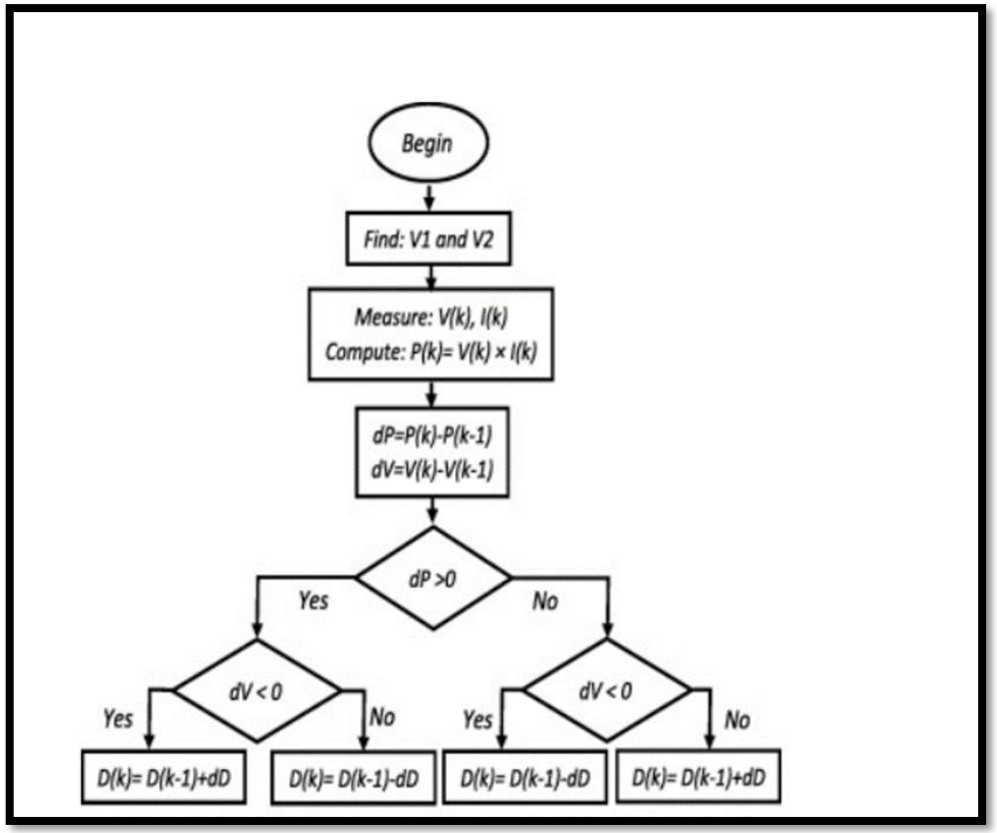


Figure 4: Decision Flowchart for P&O Algorithm

Algorithm 2- Incremental Conductance (InC)

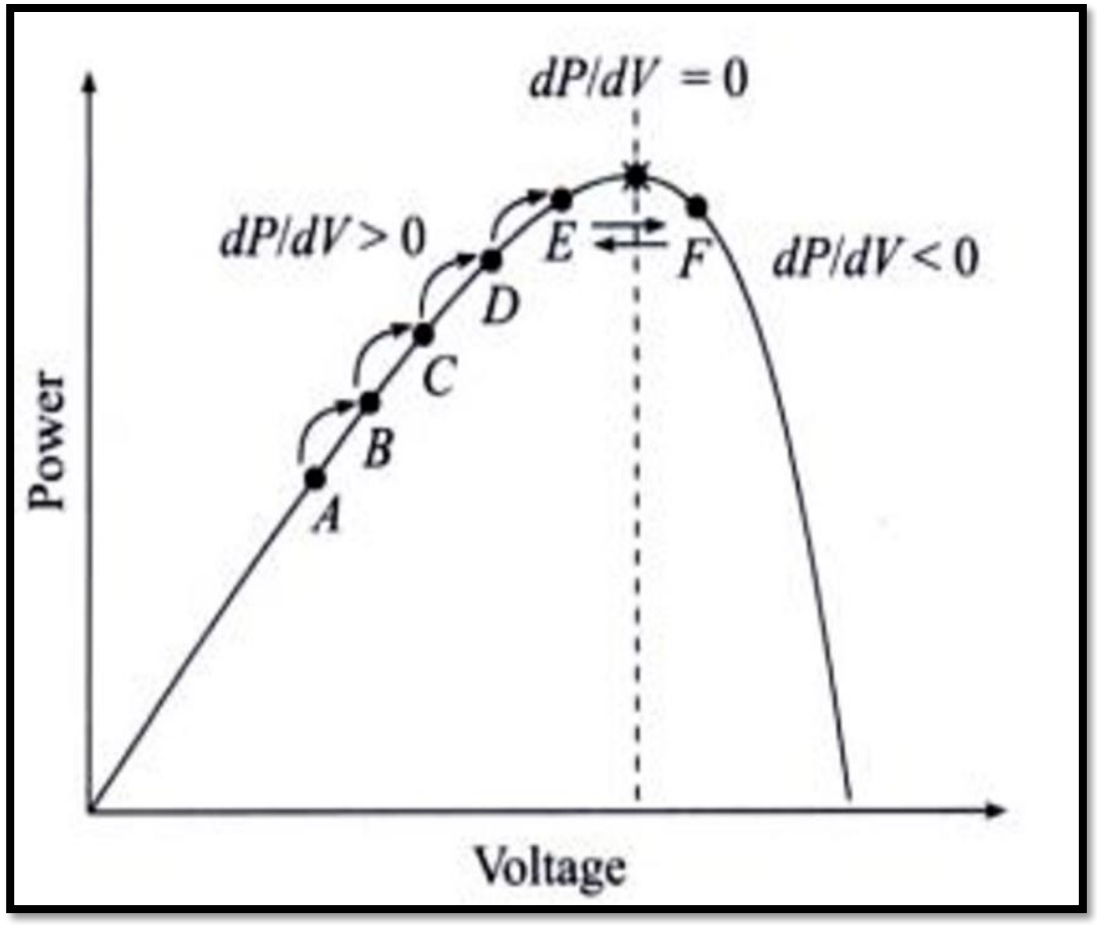


Figure 5: PV Curve using InC Algorithm

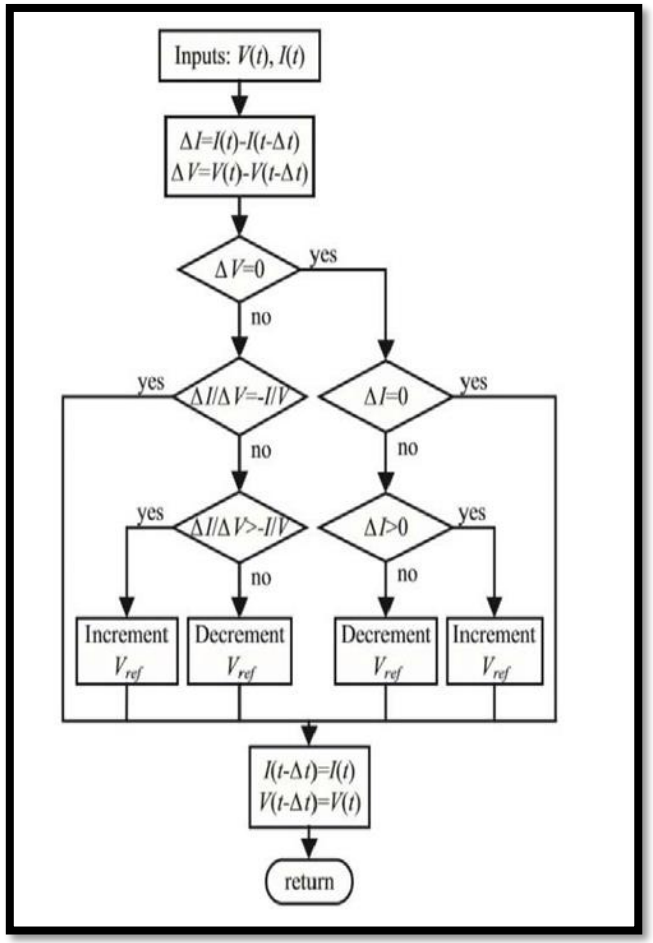


Figure 6: Decision Flowchart of InC Algorithm

Comparison Between Two Algorithms

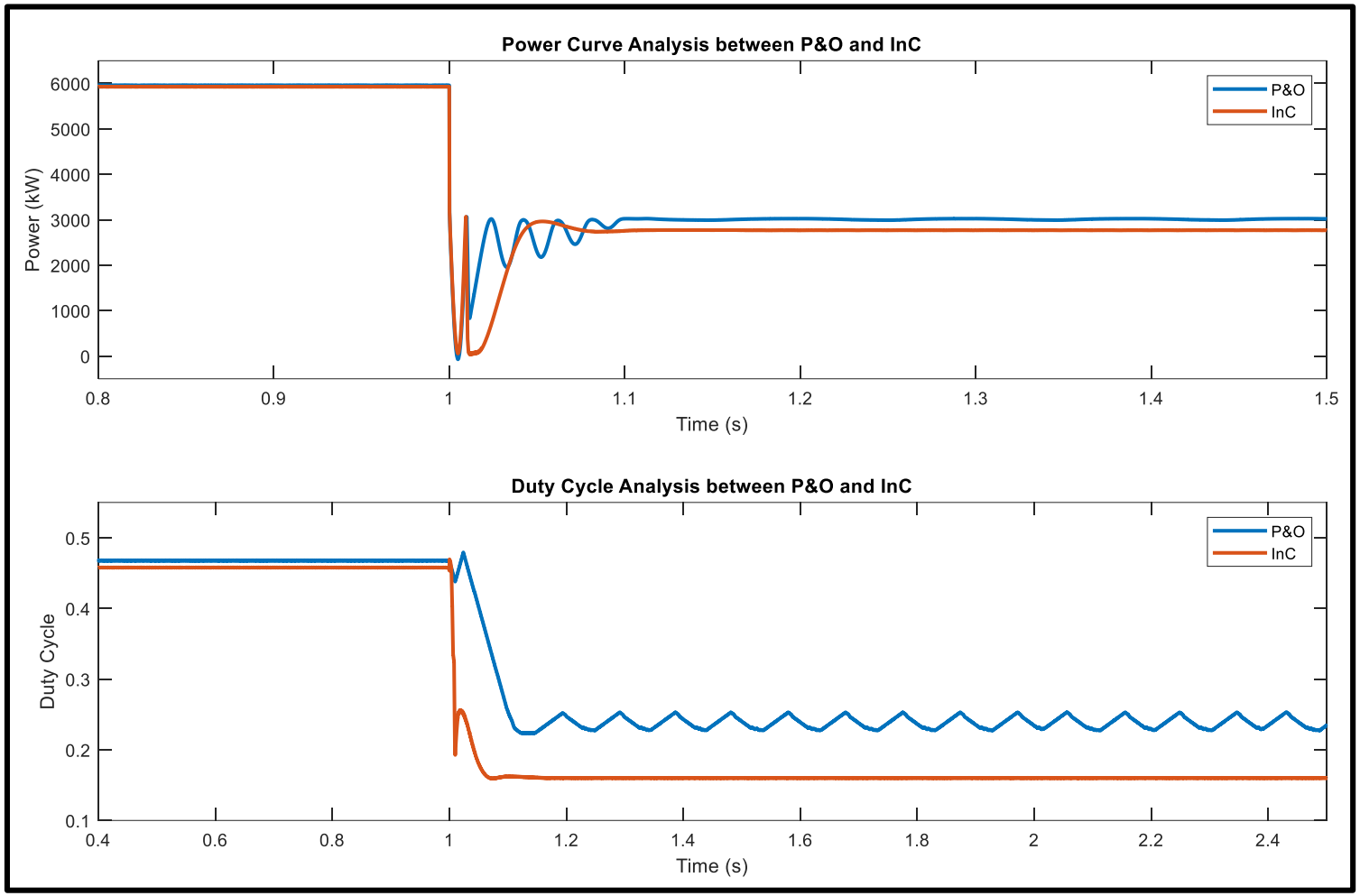


Figure 7: Comparison Between P&O And InC

Design Breakdown Cont.

Block One (Boost Convertor)

- The main purpose of the DC/DC boost converter is to convert the low DC input voltage from the PV into a higher DC voltage necessary for the inverter stage.

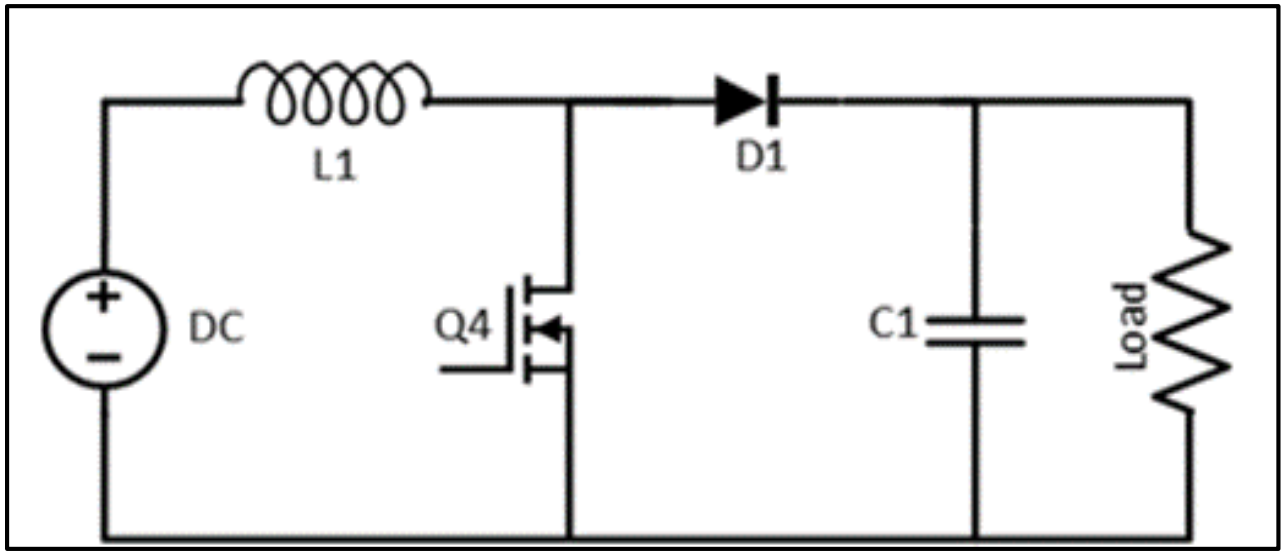


FIGURE 8: BLOCK 1 BOOST CONVERTER

Design Breakdown Cont.

Block Two (Storage)

- Stores power from either; the solar panels or the grid
  - High Irradiance periods
  - Low Peak hours
- Bi-directional converter also known as Buck/Boost Converter

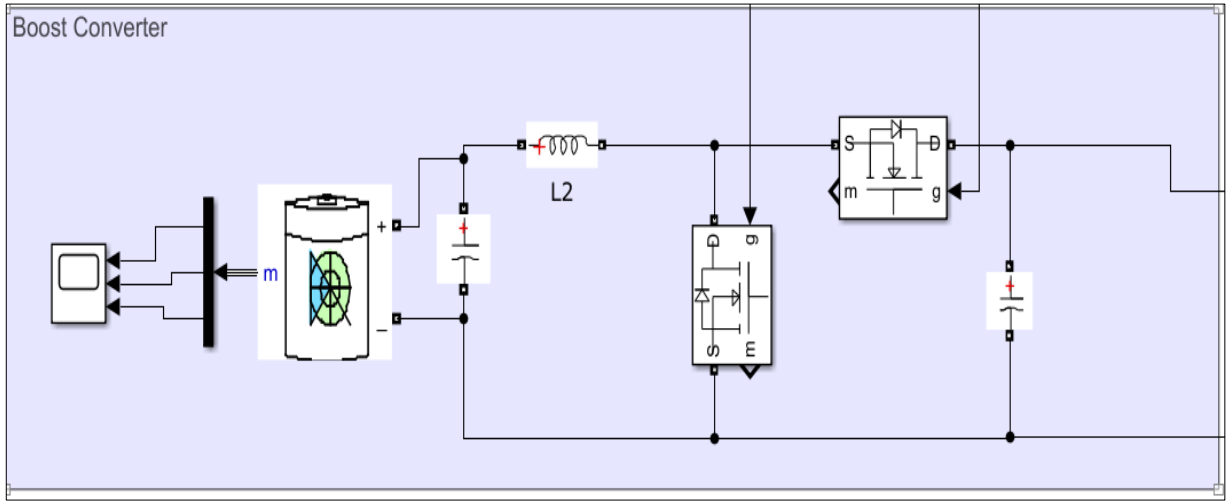


FIGURE 9: LITHIUM ION BATTERY WITH BI-DIRECTIONAL CONVERTER

Design Breakdown Cont.

Block Three (DC/AC Inverter)

- Grid connection
- DC/AC converter
  - PWM Converter controls input/output
- Maintain the DC bus at a specific value, e.g. 600V
  - PWM generates the DC voltage in form of pulses of different widths.
  - In regions where you need higher amplitude then it will generate pulses with larger widths. In this scenario, the priority is to keep the DC bus at 600 V constant.
- If the DC side has too much voltage, it will sell back to the grid
  - Vice versa if the DC power is insufficient

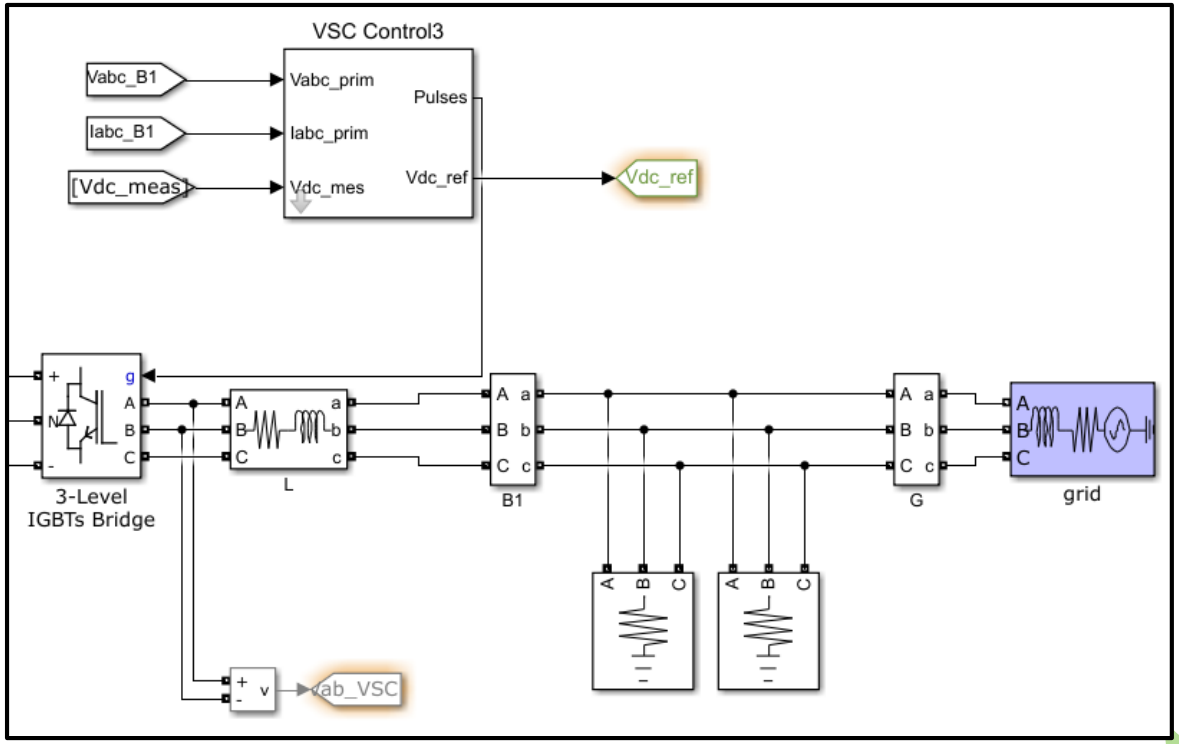


FIGURE 10: DC/AC INVERTER SCHEMATIC & LOAD

Prototype

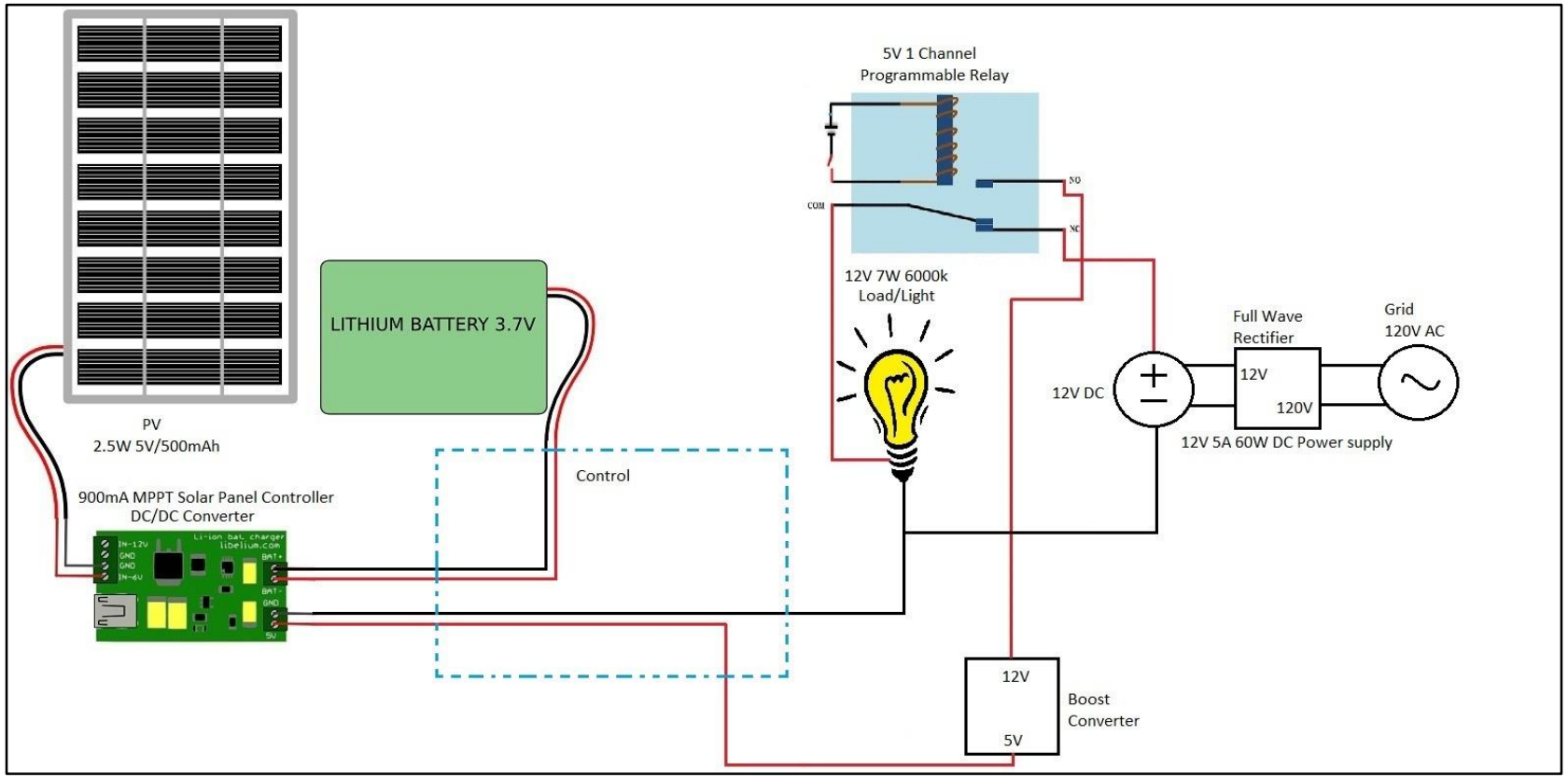


FIGURE 11: PROTOTYPE SCHEMATIC OF OVERALL DESIGN

Product Testing

Test Writer:	Thisaru Sibera					
Test Case Name:		Overall Acceptance Test			Test ID#:	AT01
Description:		Analyze efficient solar panel system power generation with battery storage microgrid. Analyze the different irradiance levels and effects on the system's efficiency			Type:	Black box
Tester Information						
Name of Tester:		Thisaru Sibera			Date:	19-Feb-20
Hardware Version:		1.0			Time	1:30pm - 2:30pm
Setup:	Model the solar panel system with battery storage microgrid on Simulink to integrate all parts of the system. Once the simulation is modeled, recreate the idea of the simulation using a microcontroller to depict the switching of power from solar panel energy to grid power.					
Test	Action	Expected Result	Pass	Fail	N/A	Comments
1	Assemble Simulink model and run	Program runs without any errors	✔			
2	Adjust for different irradiance levels and depict results on the system	The system should efficiently and cost effectively adjust for whichever scenerio	✔			
3	Assemble microcontroller to behave in the same manner	Based of battery level, the system should switch from battery to grid power	✔			
Overall Test Result:			✔			

FIGURE 12: ACCEPTANCE TEST

Test Results

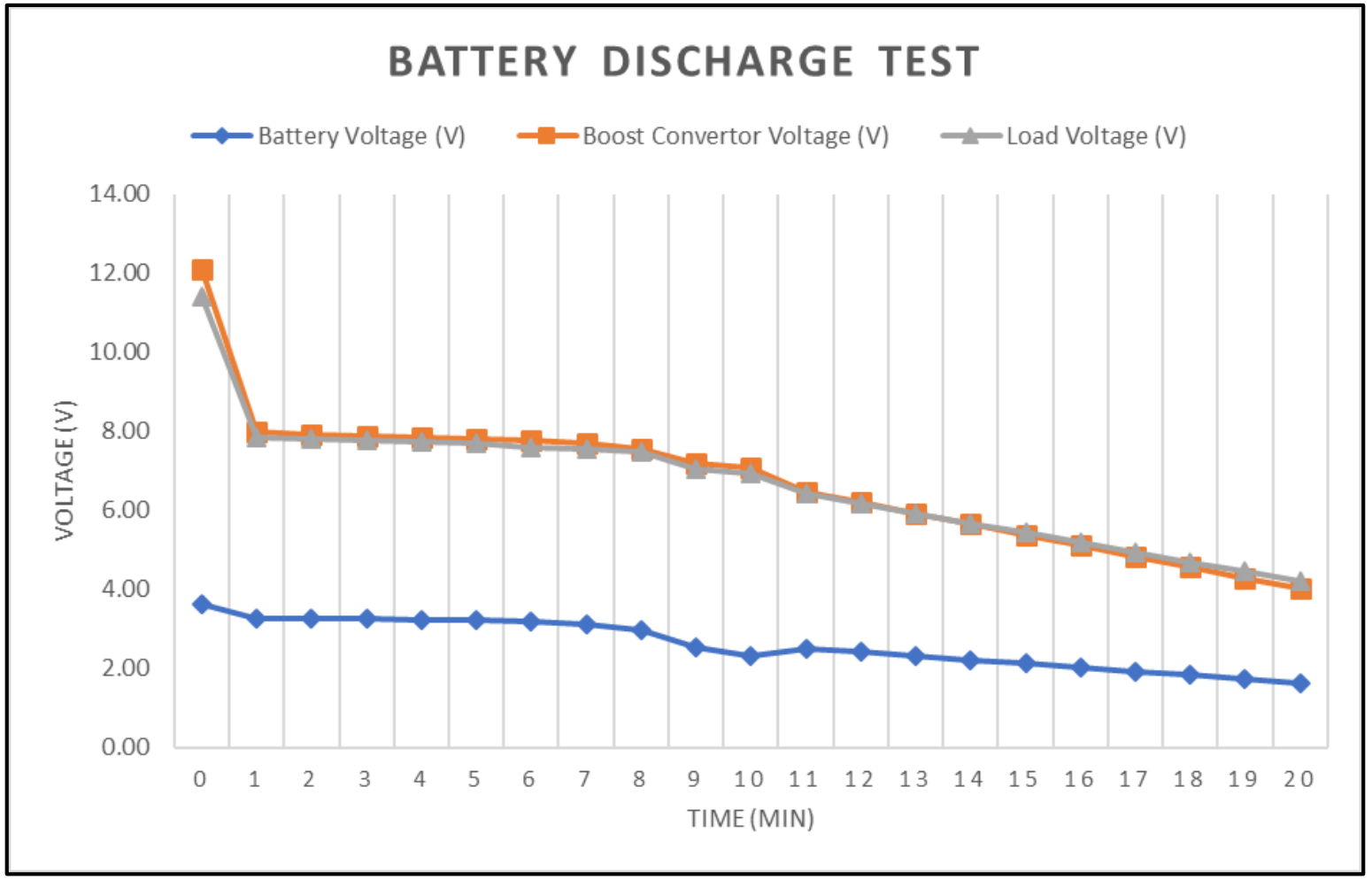


FIGURE 13: BATTERY DISCHARGE TEST

Test Results

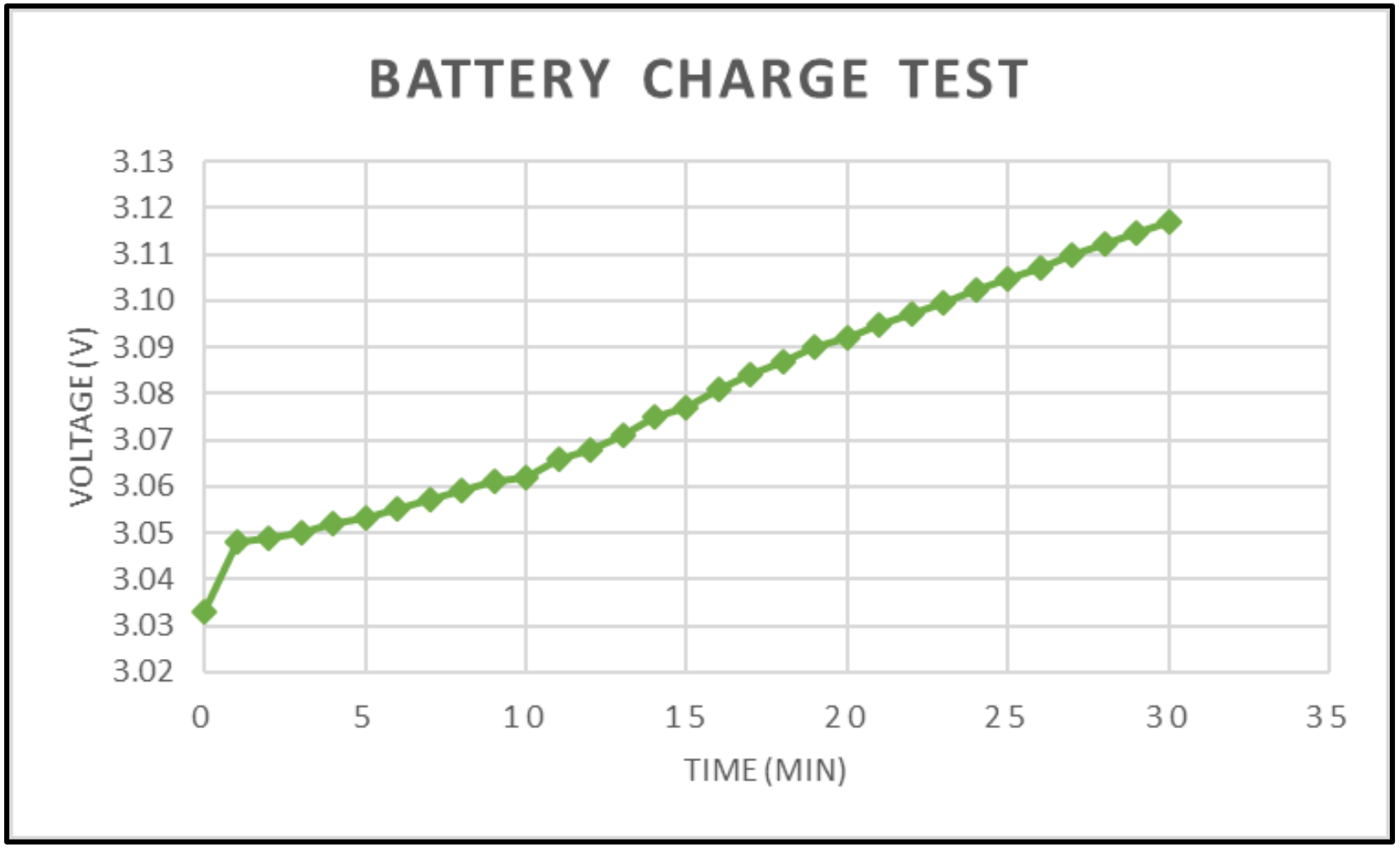
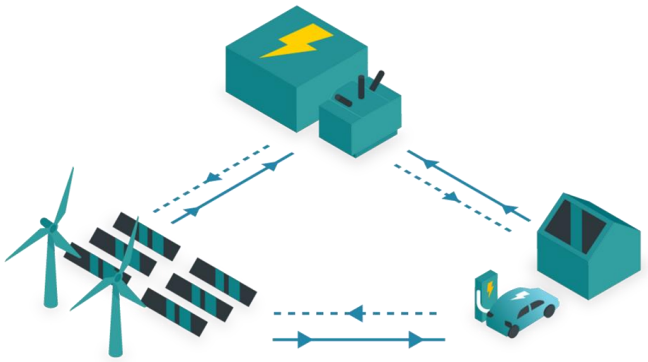


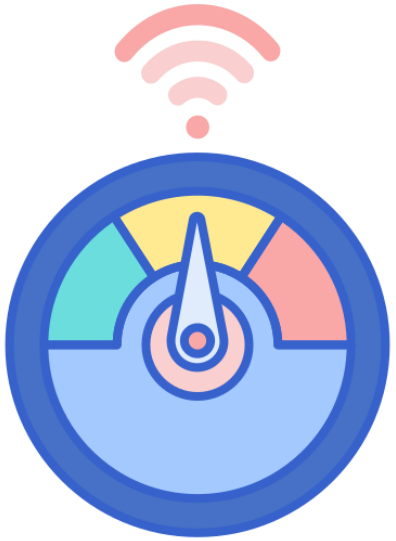
FIGURE 14: BATTERY CHARGE TEST

Challenges Faced & Lessons Learned

- **Challenges**
  - Faulty Equipment
  - Design Implementation
  - Hands-On Skills
  - Covid-19
- **Lessons Learned**
  - PCB Development
  - DC/DC Converters
  - Video Editing/Formatting
  - Team Management

Future Steps





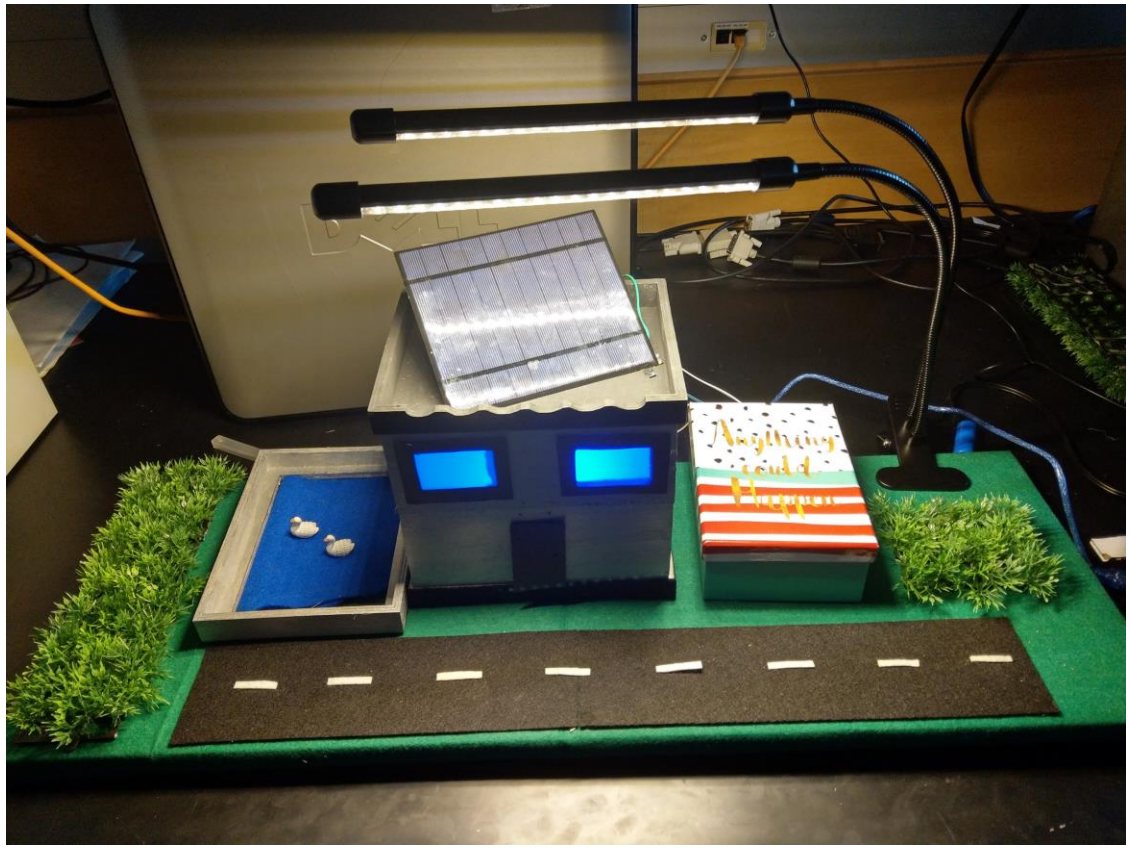
Group Contribution Matrix

	Umer	Thisaru	Rizwan	Uzair	Kevin
Research					
•Algorithms				✓	✓
•High Level SLD				✓	✓
•Boost Converter	✓				
•MPPT Controller	✓	✓			
Timeline Management			✓		
Designing Test Inputs		✓	✓		
Simulation	✓		✓		
Report Layout		✓		✓	✓
Prototype Building		✓			
Prototype Testing		✓			
Report Formatting	✓			✓	✓
Project Management			✓		

FIGURE 15: GROUP CONTRIBUTION TABLE

Thank You

Demo Video



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