Title: HYBRID SOLAR PV–HYDRO CONTROLLER FOR AN AUTONOMOUS DC MICROGRID

Datasets: Solar PV details, boost converter details, fuzzy logic details and results

Appendices: DCMG system measurements, DCMG system control variables and set conditions

DATASETS

1. Dataset A: Solar PV details

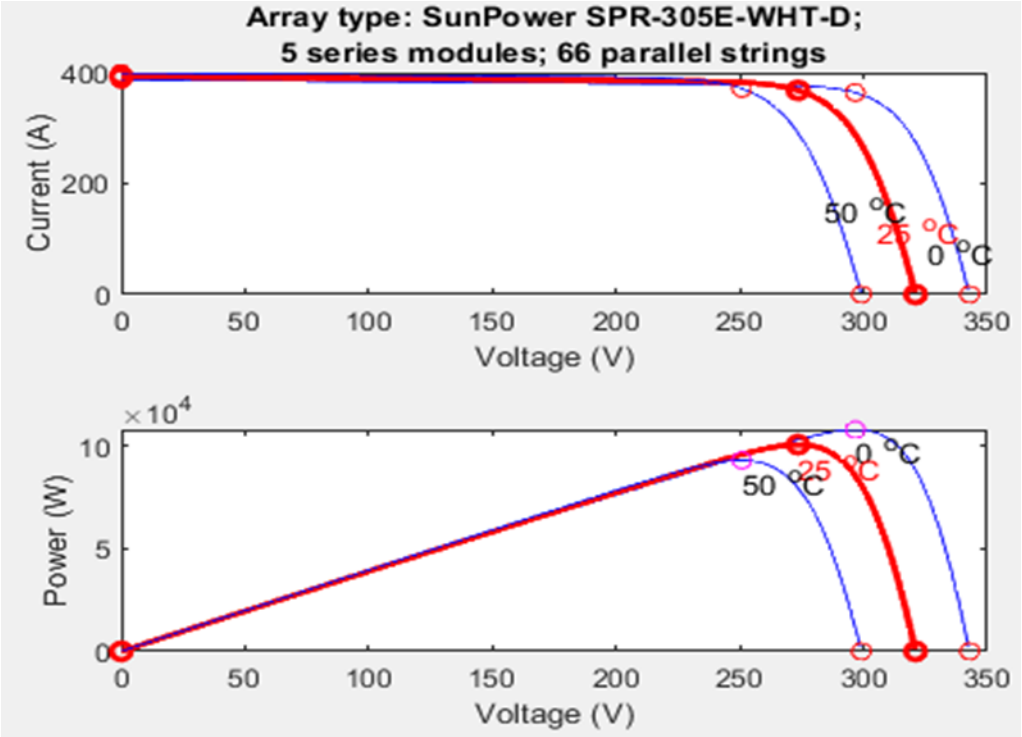


Figure 1: 100 kW PV array at an irradiance of 1000 W/m^2, temperature at 25 ℃ and 50 ℃ respectively

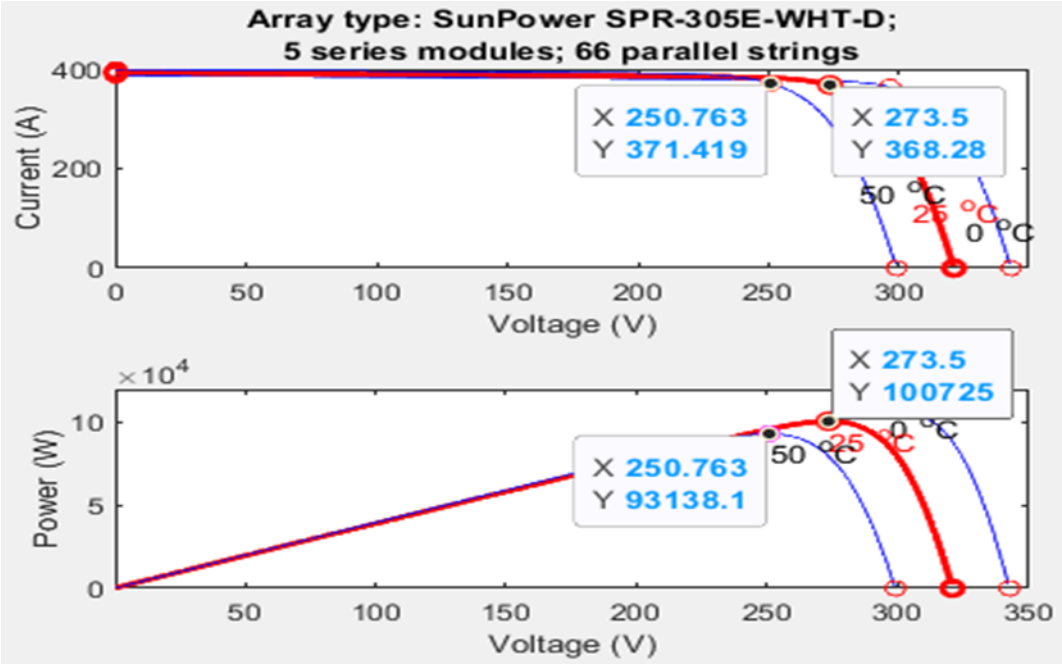


Figure 2: 100 kWp PV showing the actual values at 25℃ and 50℃ respectively

2. Dataset B: Boost converter details

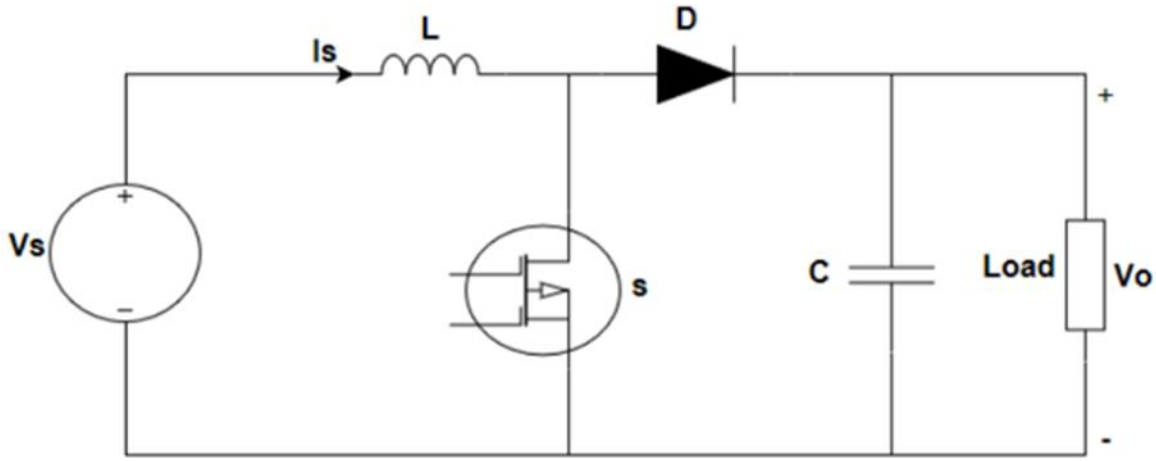


Figure 3: A boost converter circuit with diode and MOSFET

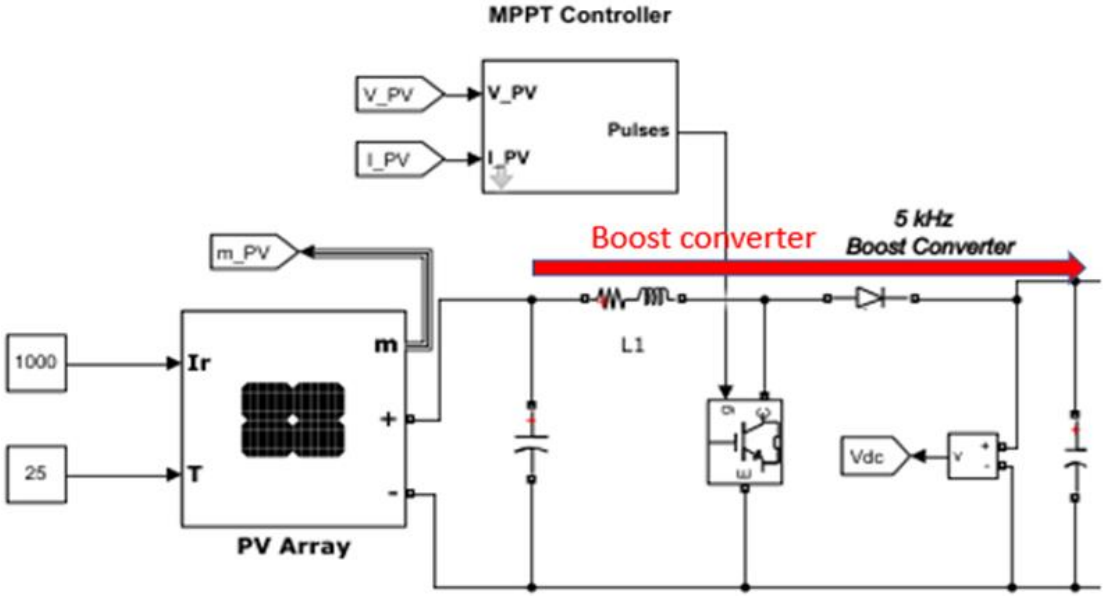


Figure 4: DC-DC boost converter with controller

3. Dataset C: Microgrid system Flowchart

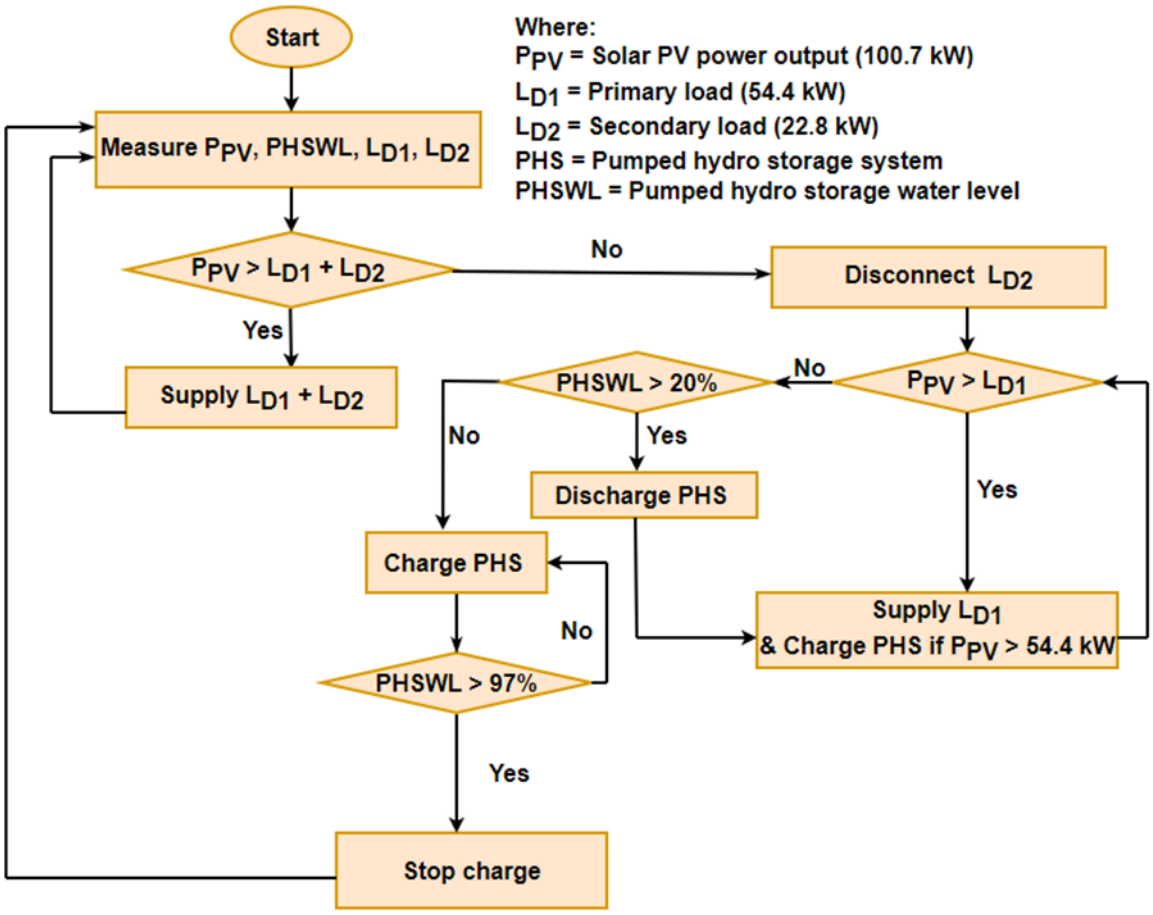


Figure 5: Flowchart of the microgrid optimization process

4. Dataset D: Fuzzy Logic details

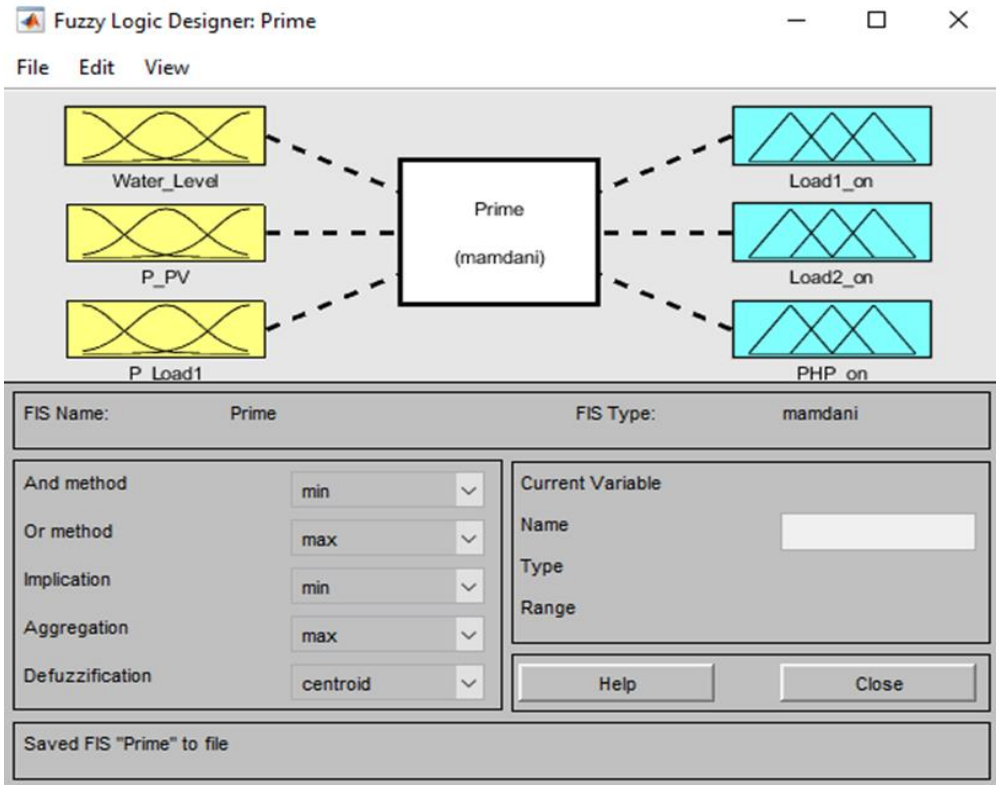


Figure 6: Fuzzy interface model

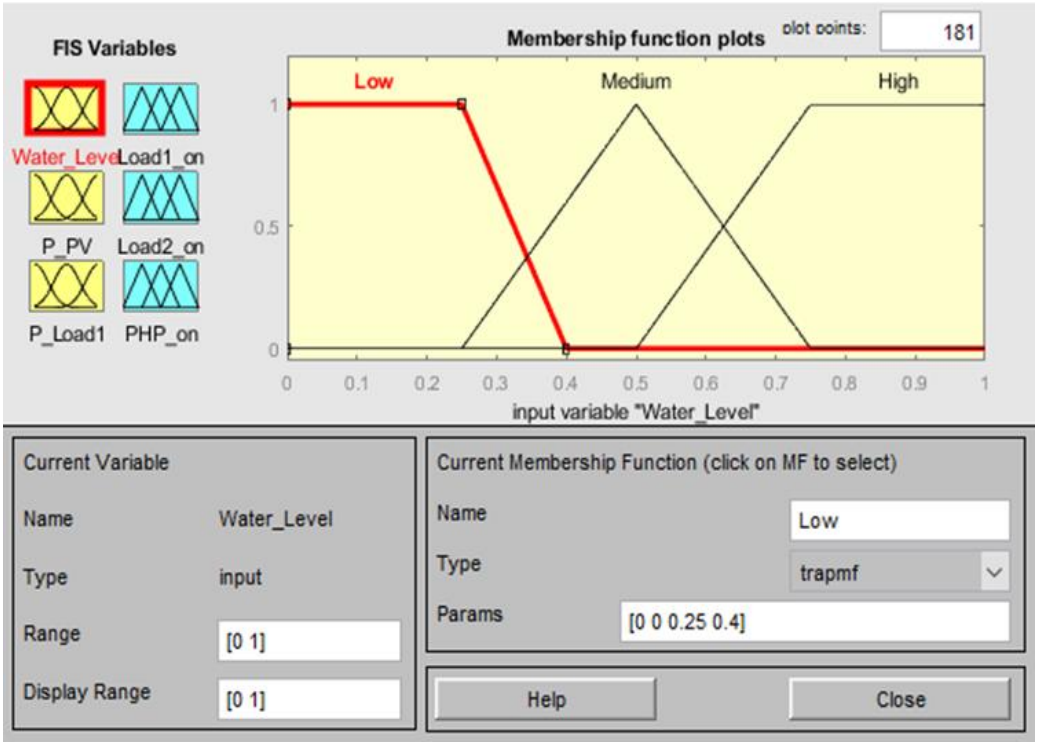


Figure 7: Membership function of water level

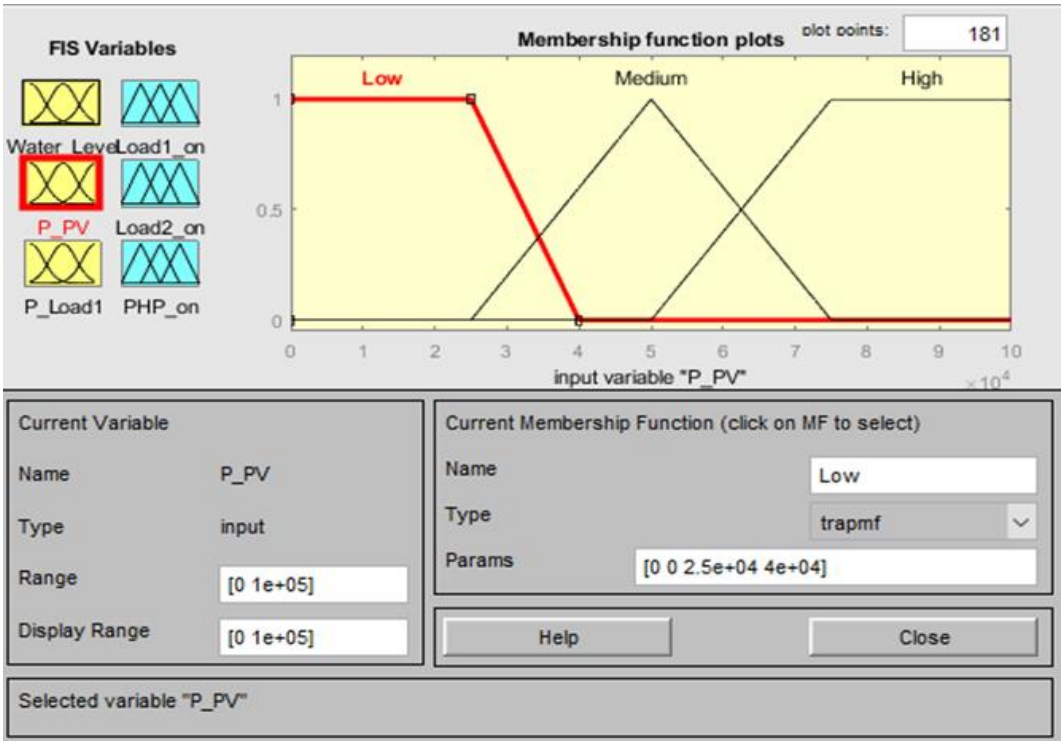


Figure 8: Membership function of Solar PV

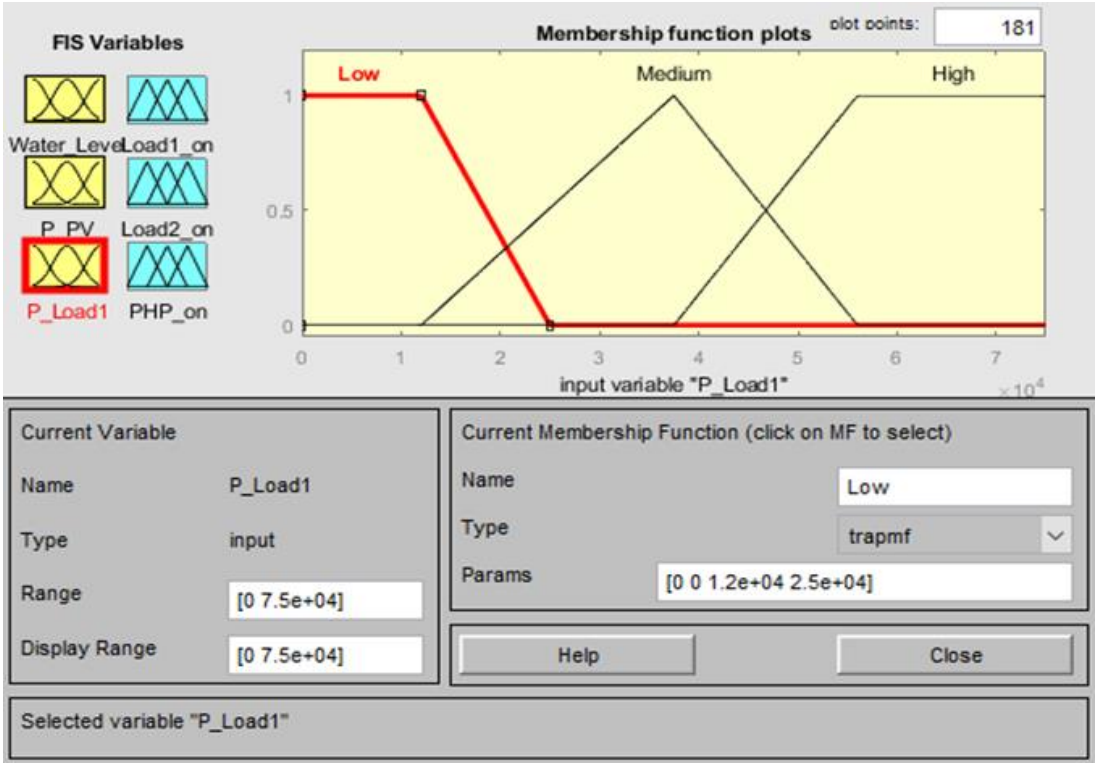


Figure 9: Membership function of power load1

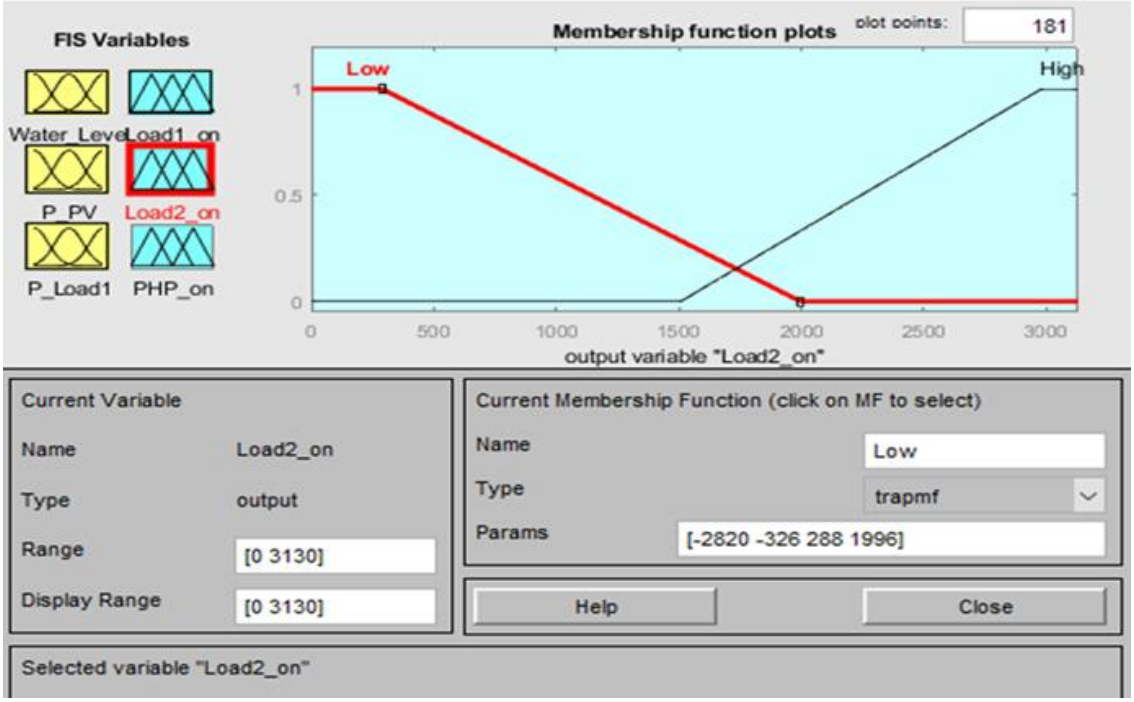


Figure 10: Membership function of load2

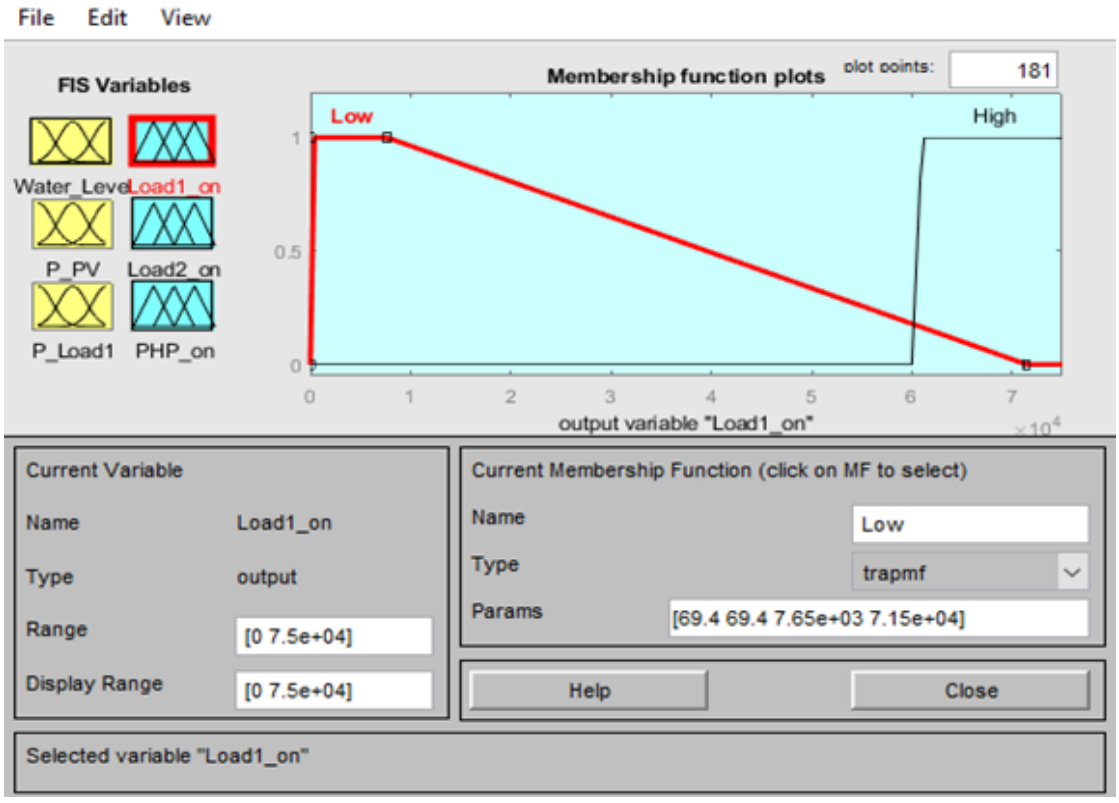


Figure 11: Membership function of load1

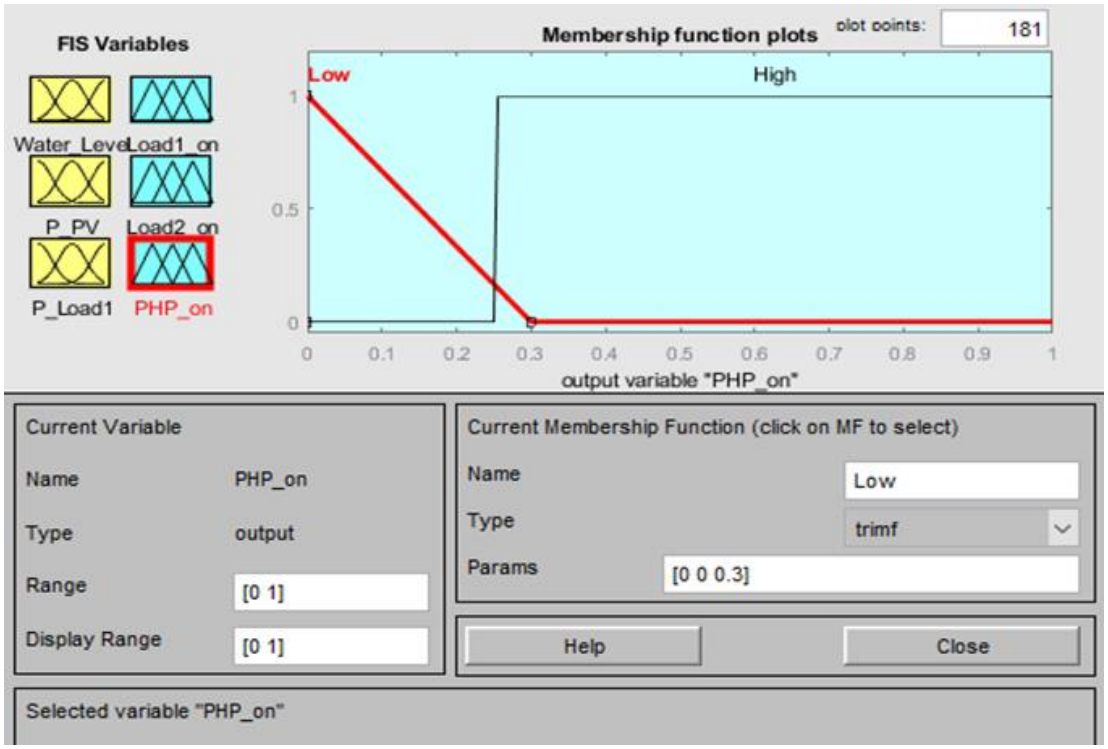


Figure 12: Membership of pumped hydro storage

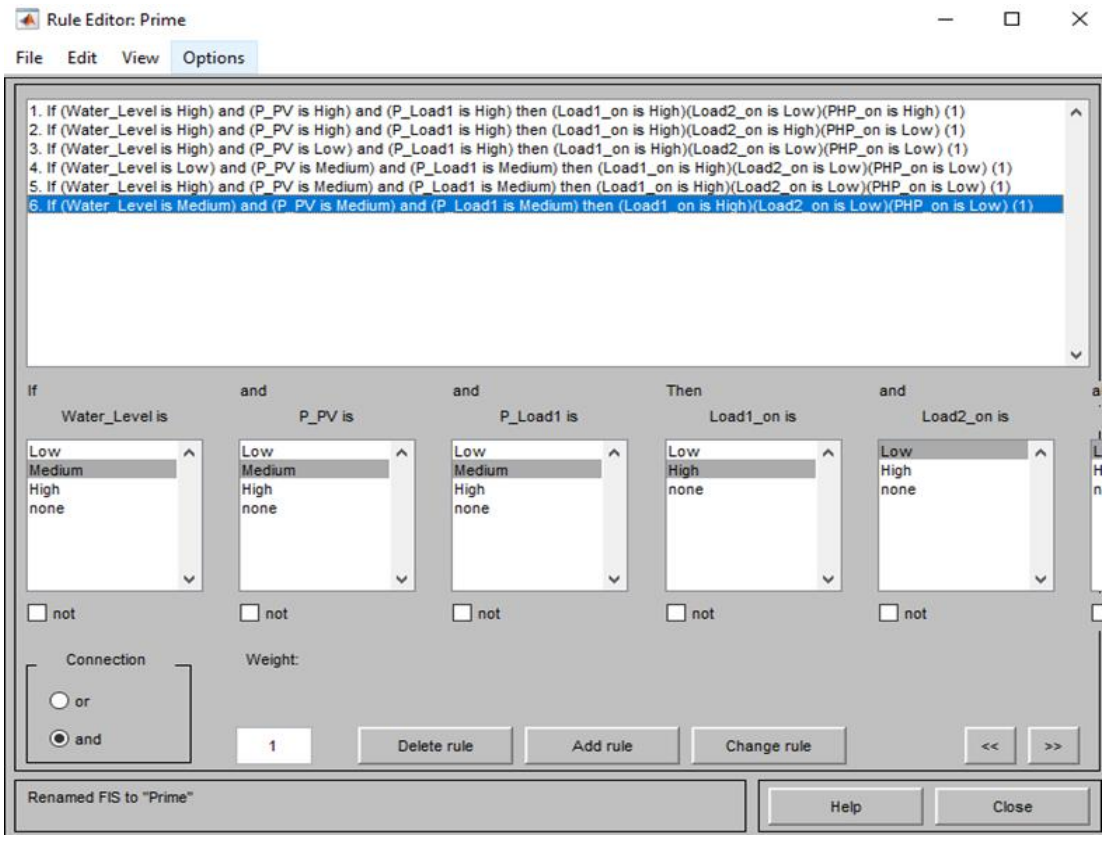


Figure 13: Fuzzy logic controller rule editor

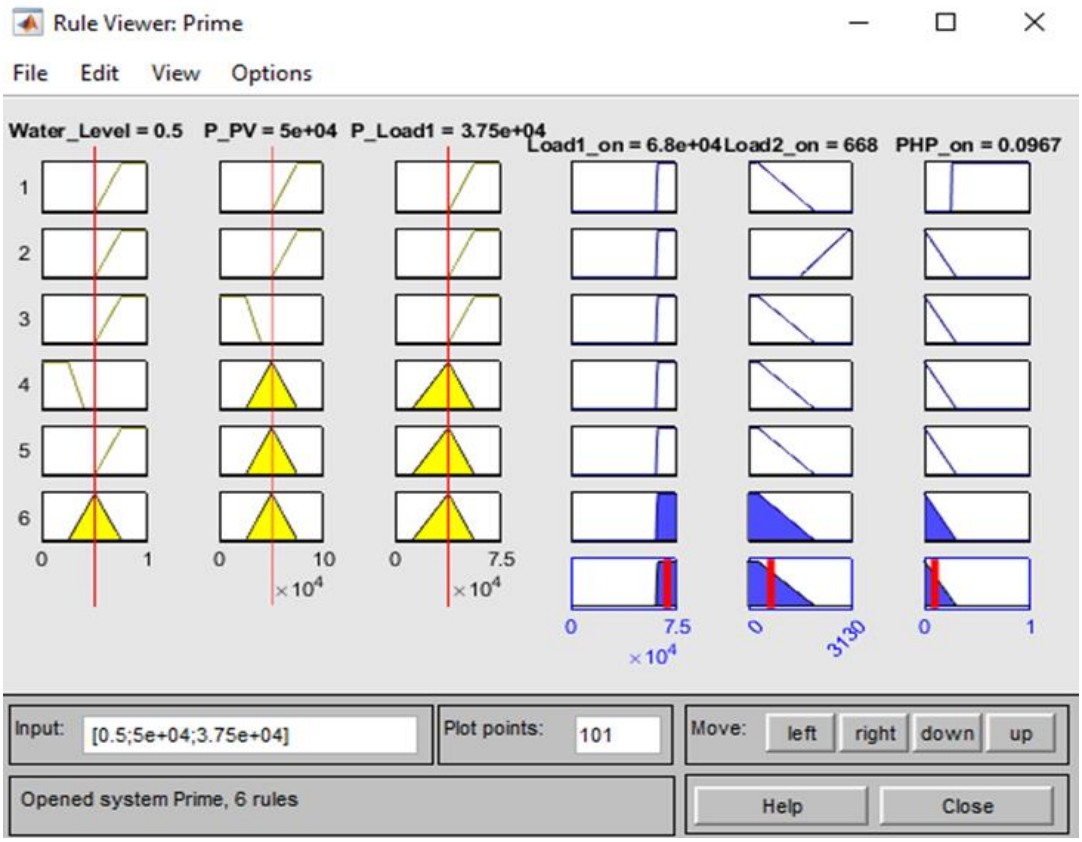


Figure 14: Rule viewer

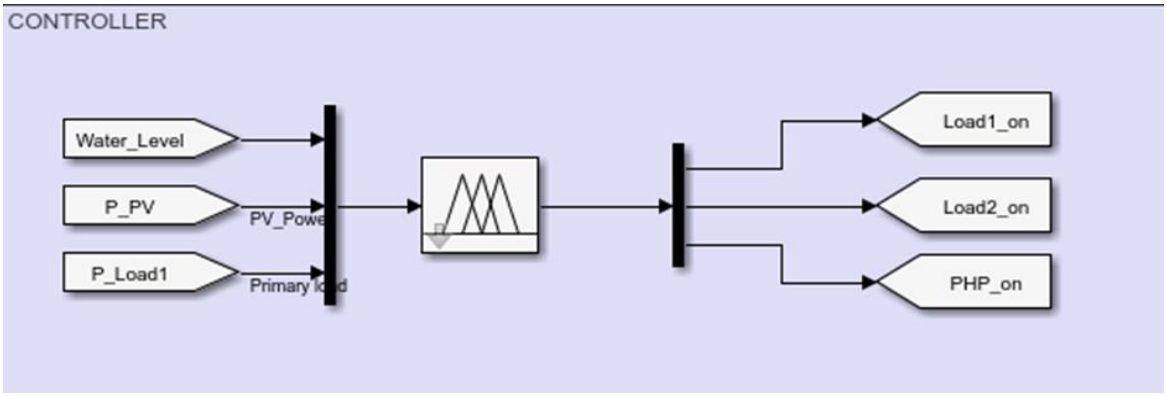


Figure 15: Complete fuzzy logic controller

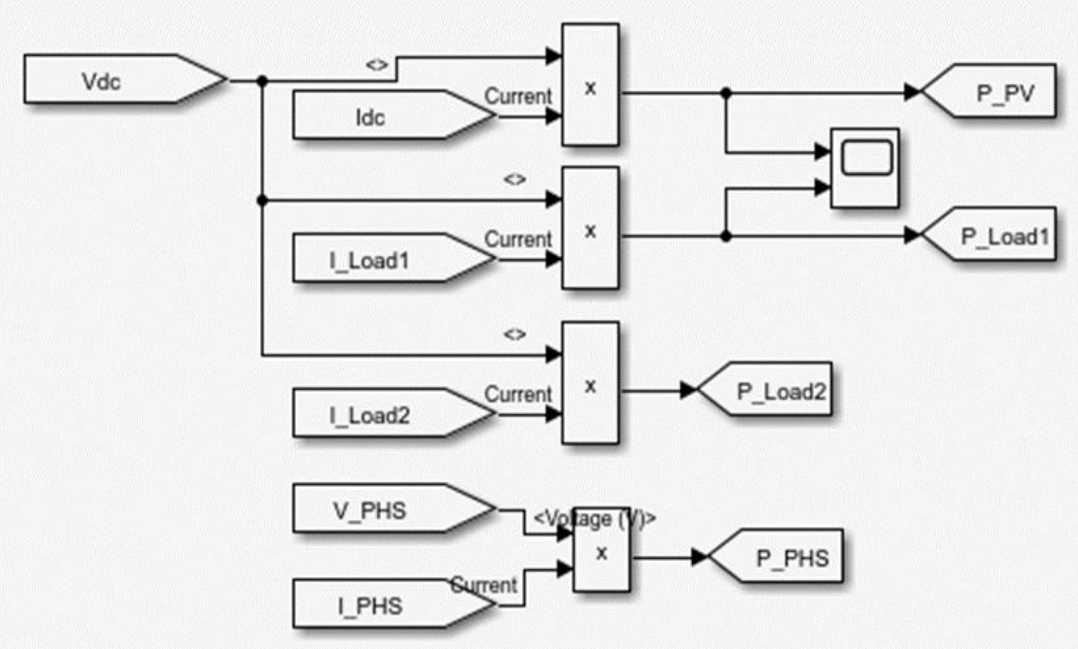


Figure 16: Fuzzy logic controller inputs

5. Dataset E: Solar PV–pumped hydro storage system model

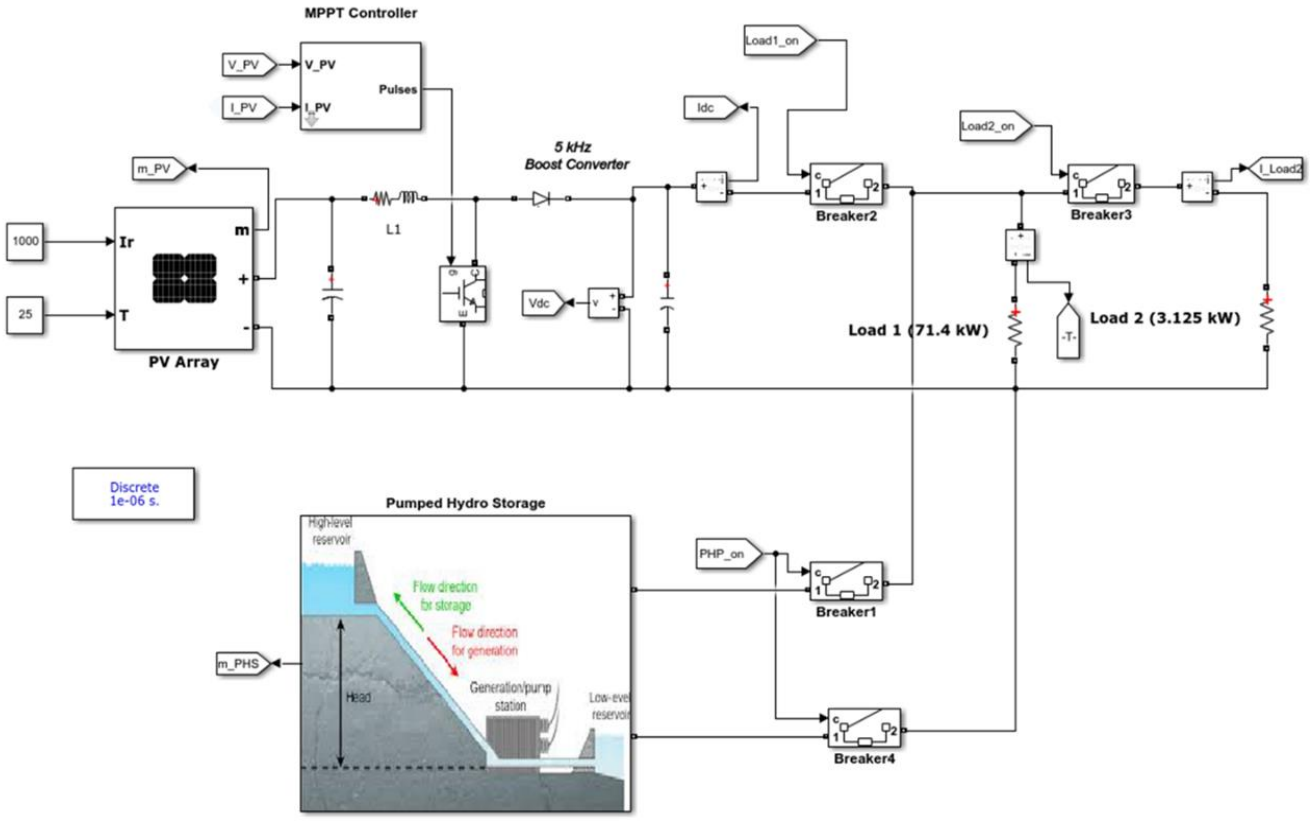


Figure 17: Solar PV–pumped hydro storage DC Microgrid

6. Dataset F: Solar PV, boost converter and PHS results

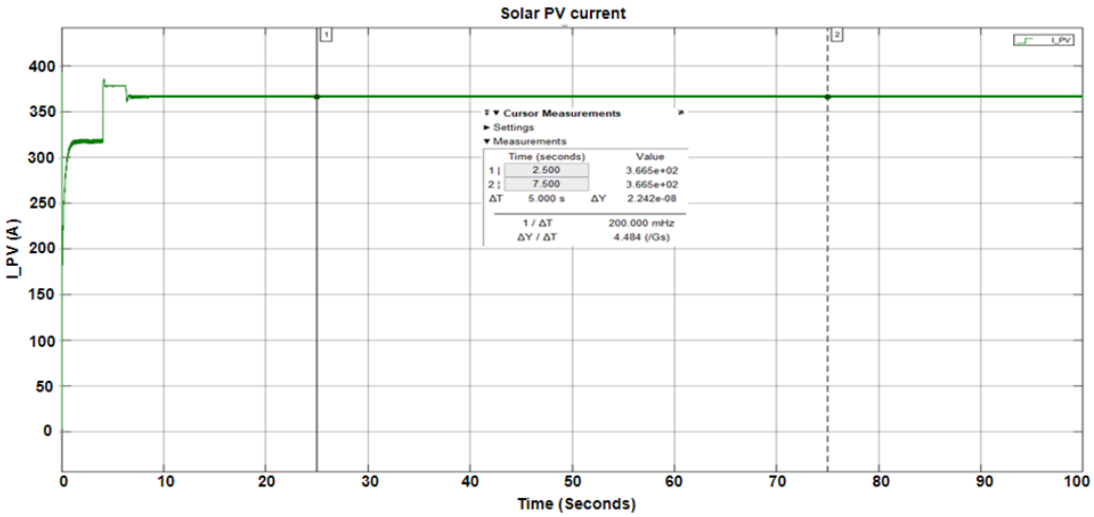


Figure 18: Solar PV system output current

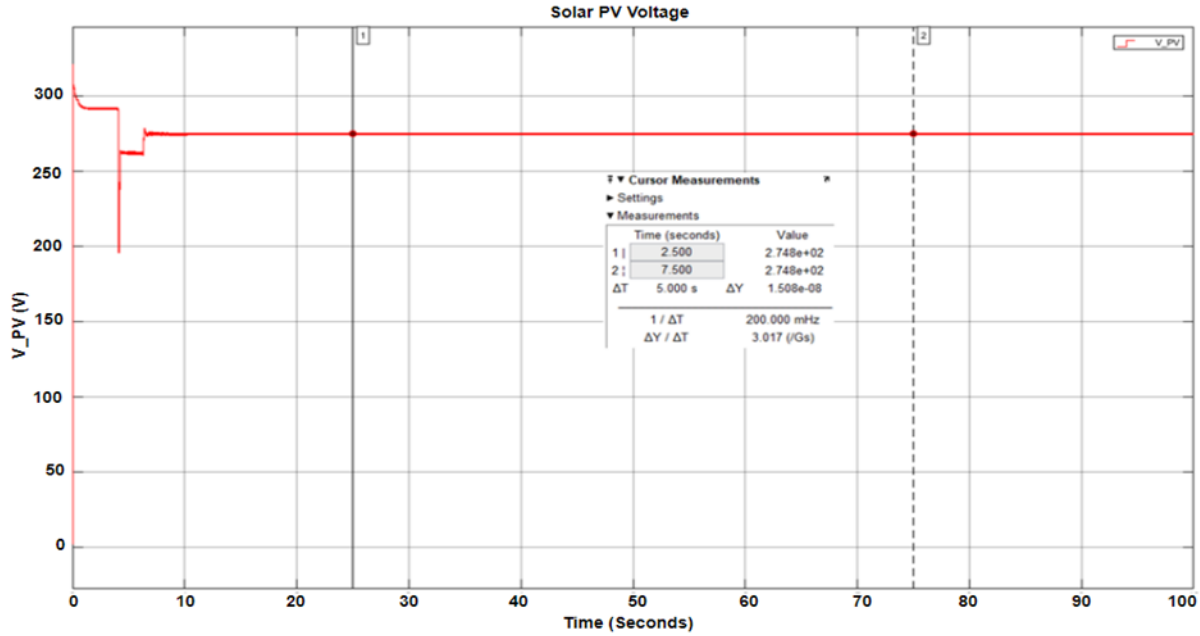


Figure 19: Solar PV system output Voltage

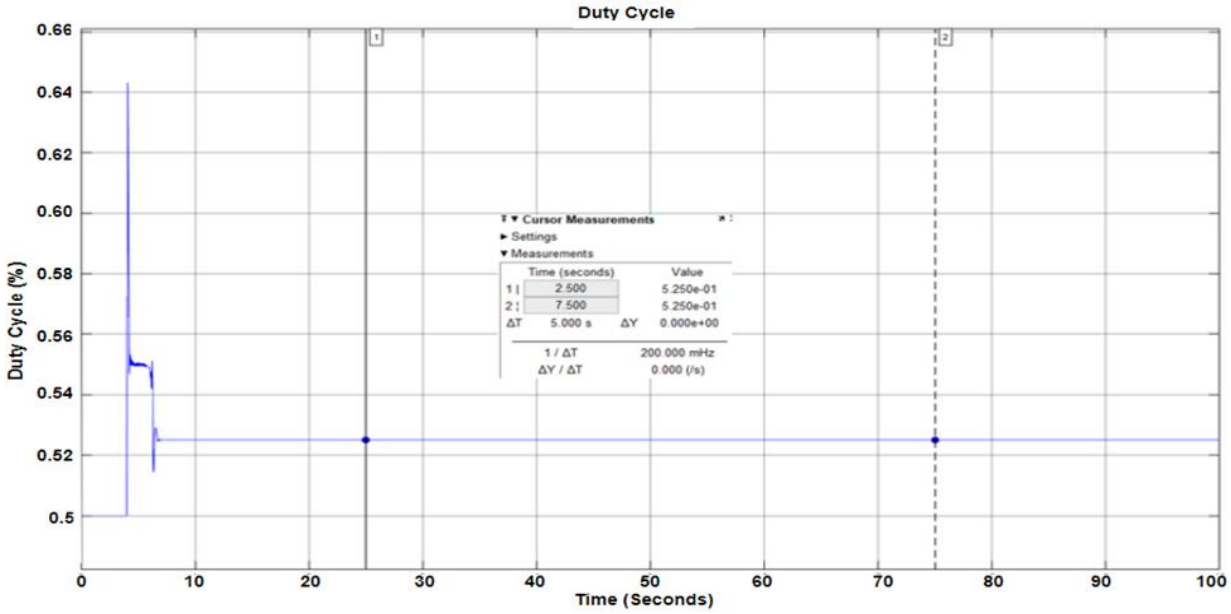


Figure 20: Solar PV system initial variation duty cycle

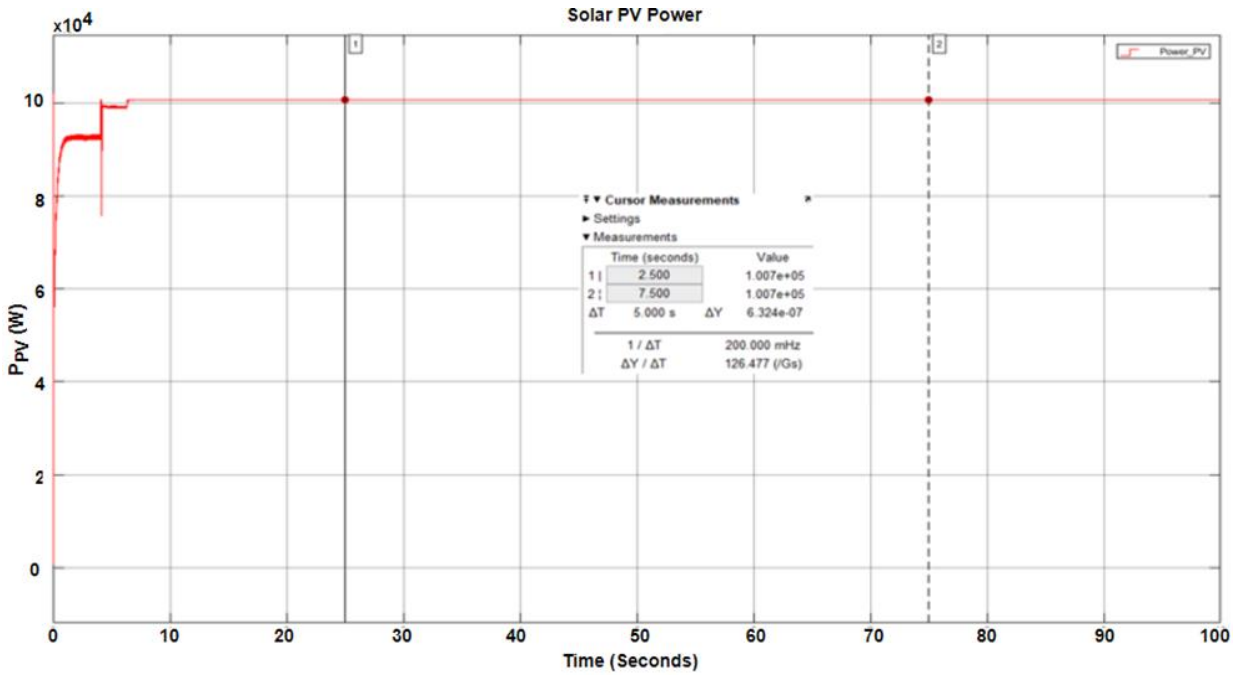


Figure 21: Solar PV system output Power

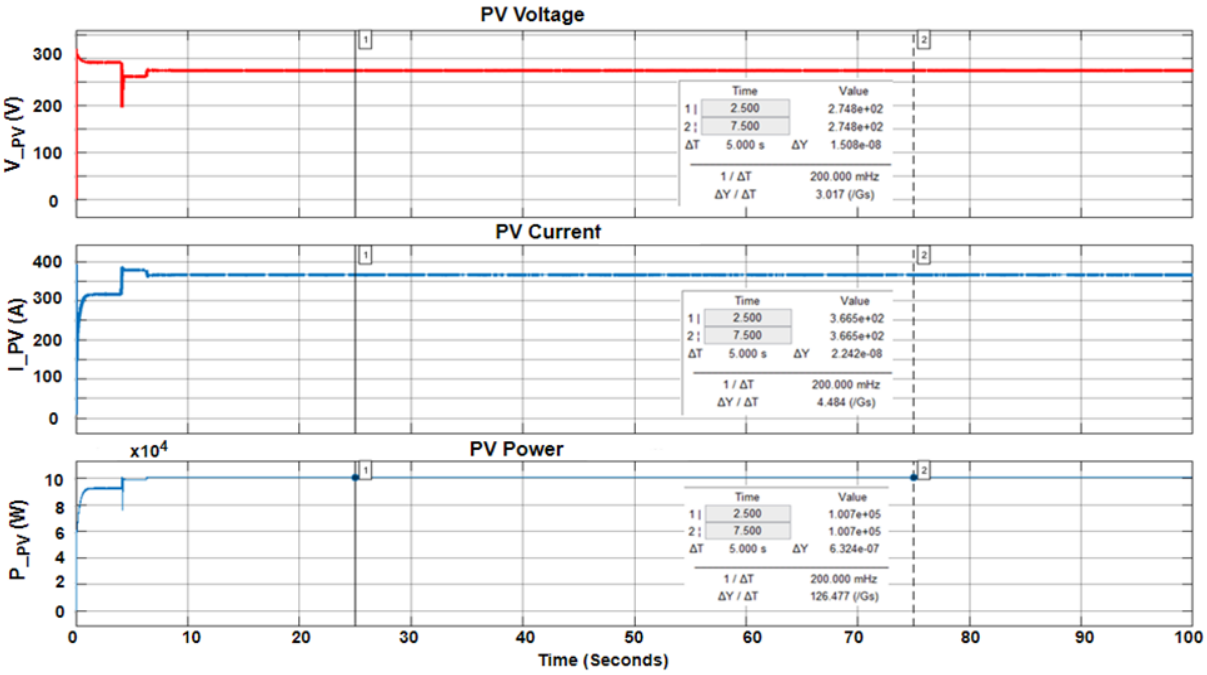


Figure 22: Simulated output values of the PV system

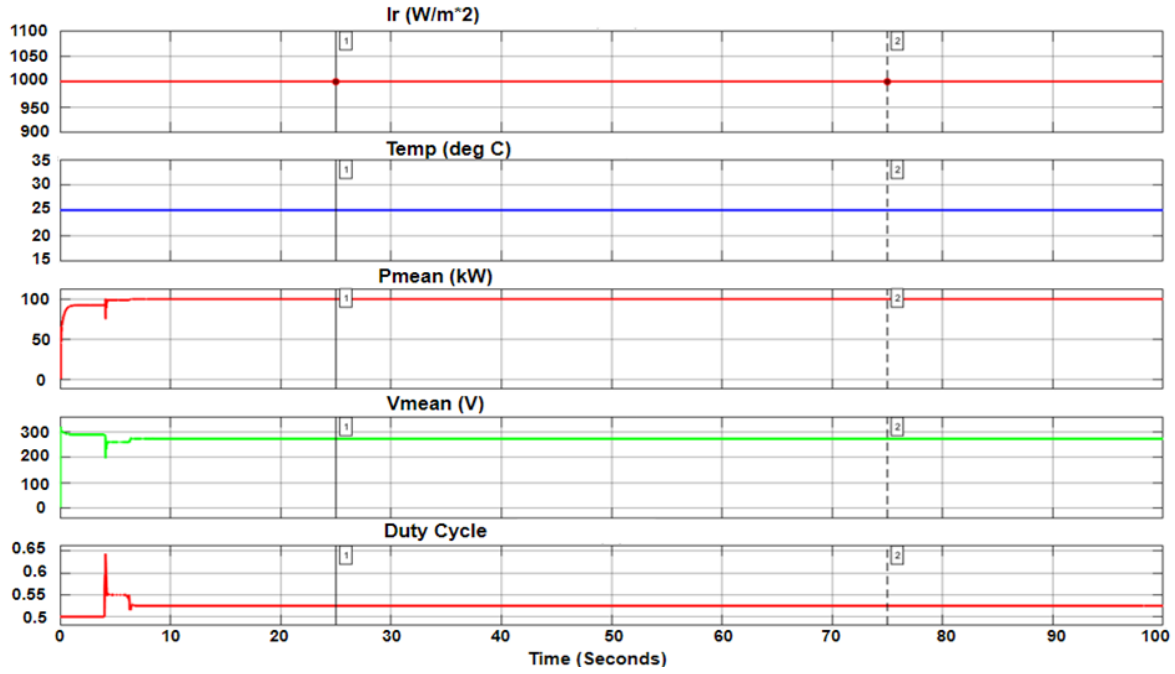


Figure 23: Solar PV system simulated values: solar irradiance, temperature, etc

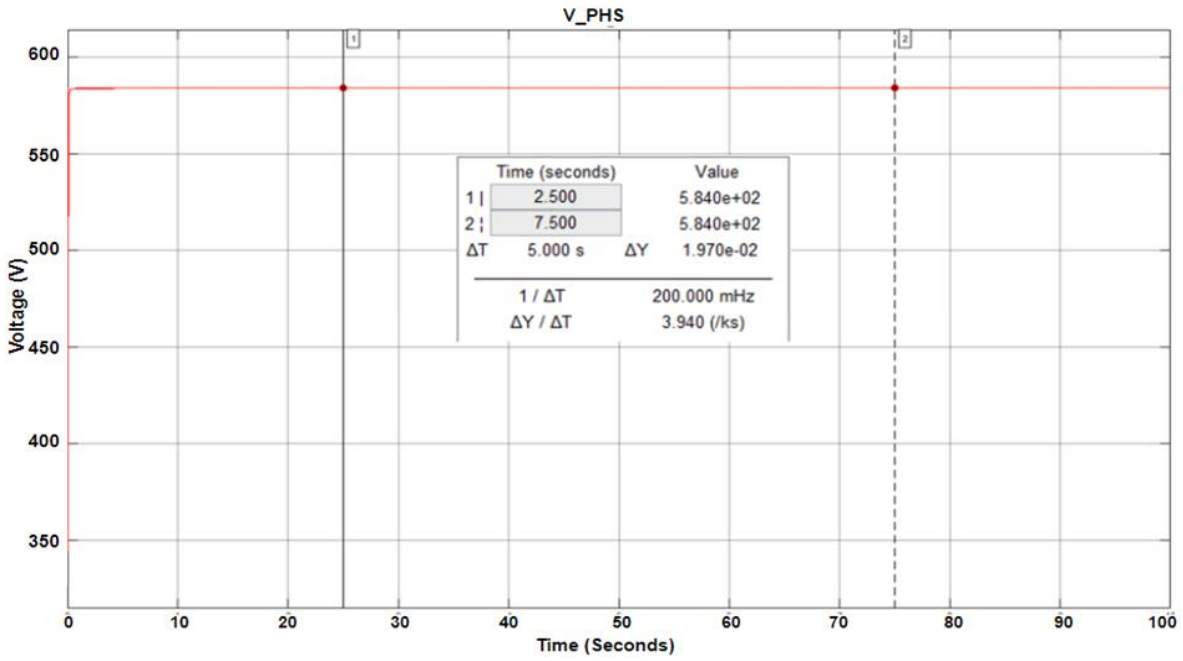


Figure 24: DC-DC boost converter Output voltage

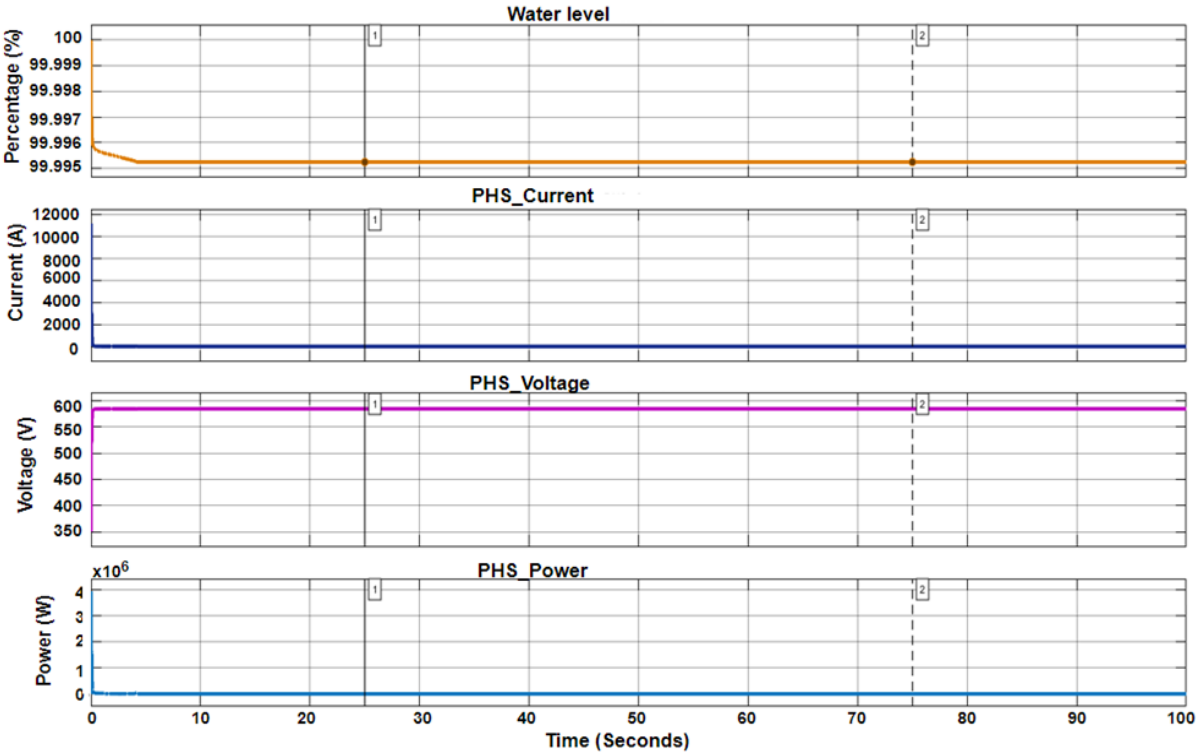


Figure 24: Reservoir water level, PHS current, voltage and available power

Table 1: Scenarios, description and conditions

Description	L_{D1}	L_{D2}	PHSS
Scenario 1 ($P_{PV} > L_{DT}$)			
The total power produced by the solar PV is greater than the total load demand and the excess power is used to pump water up the reservoir.	ON	ON	ON
Scenario 2 ($P_{PV} = L_{DT}$)			
The total power generated is equal to the load demand. The reservoir was turned off during this time because the water level had reached the upper permissible limit while still supplying loads 1 and 2. As a result, the PHSS is kept in reserve mode.	ON	ON	OFF
Scenario 3 ($P_{PV} < L_{DT}$)			
The PHSS is discharging because the load demand exceeds the power generated. Because the PHSS and solar PV output is only enough to power load 1, the load 2 is disconnected.	ON	ON	OFF
Scenario 4 (PHSWL > 20%)			
In this scenario, the power from the PHSS was used to augment the power supply to meet the total load demand (L_{DT}).	ON	ON	ON
Scenario 5 (PHSWL < 20%)			
In this scenario, the PHSS has reached its limit of discharge, hence, it was disconnected and LD2 was shut down. The PHSS was charged with the excess power generated from the solar PV.	ON	OFF	OFF
Scenario 6 (PHSWL $\geq L_{DT}$)			
During this stage, the PHSS was used to supplement power to the load until the water level in the reservoir drops to 20% and gets disconnected.	ON	ON	ON

7. Dataset G: Scenario 1 (where $P_{PV} > L_{DT}$)

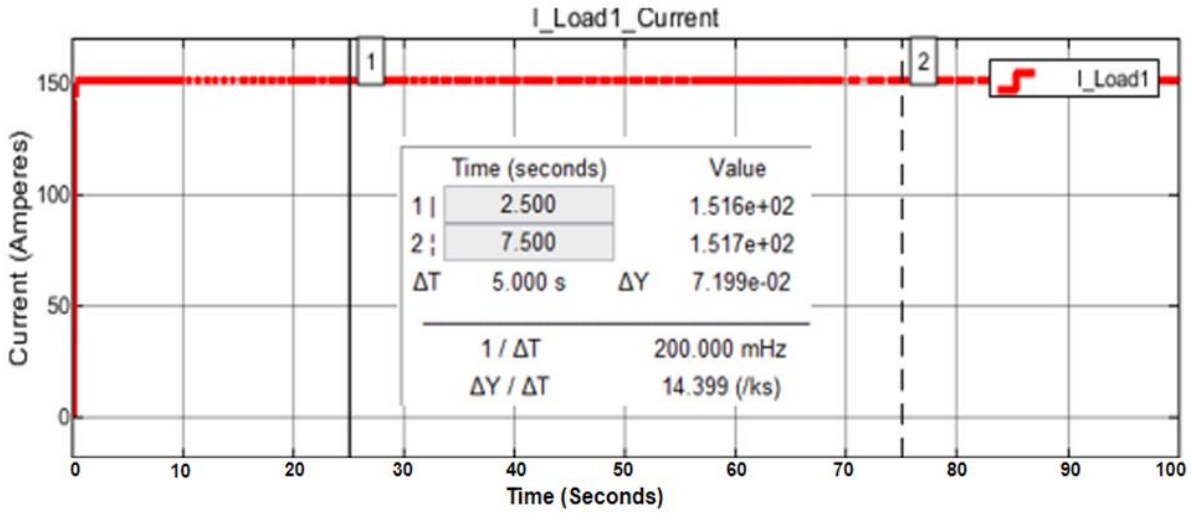


Figure 25: Current flowing through primary load (Load 1)

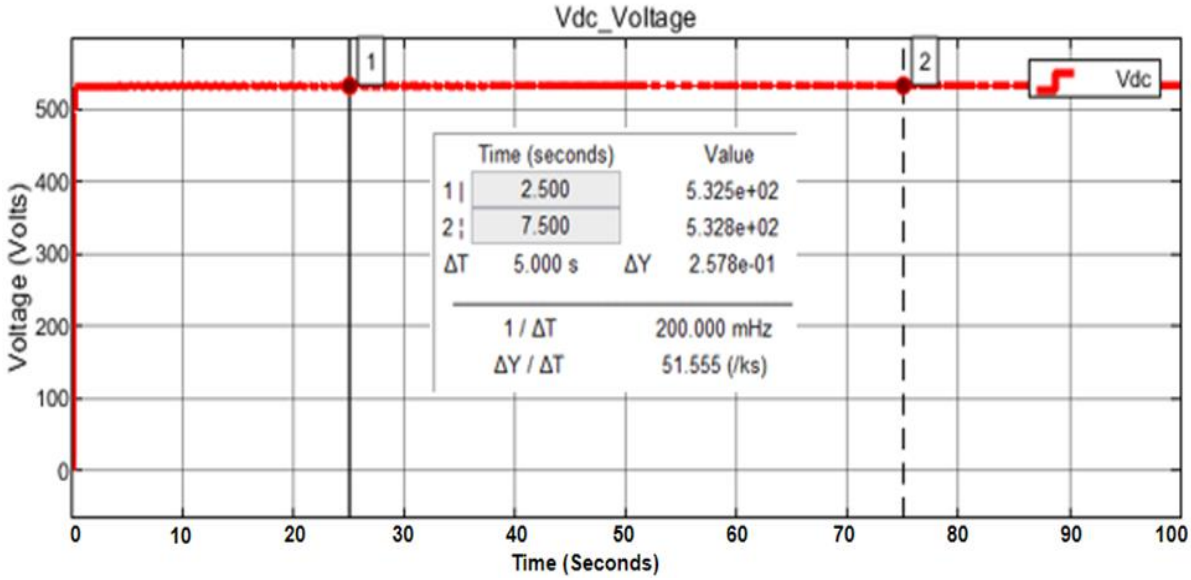


Figure 26: Voltage across primary load (Load 1)

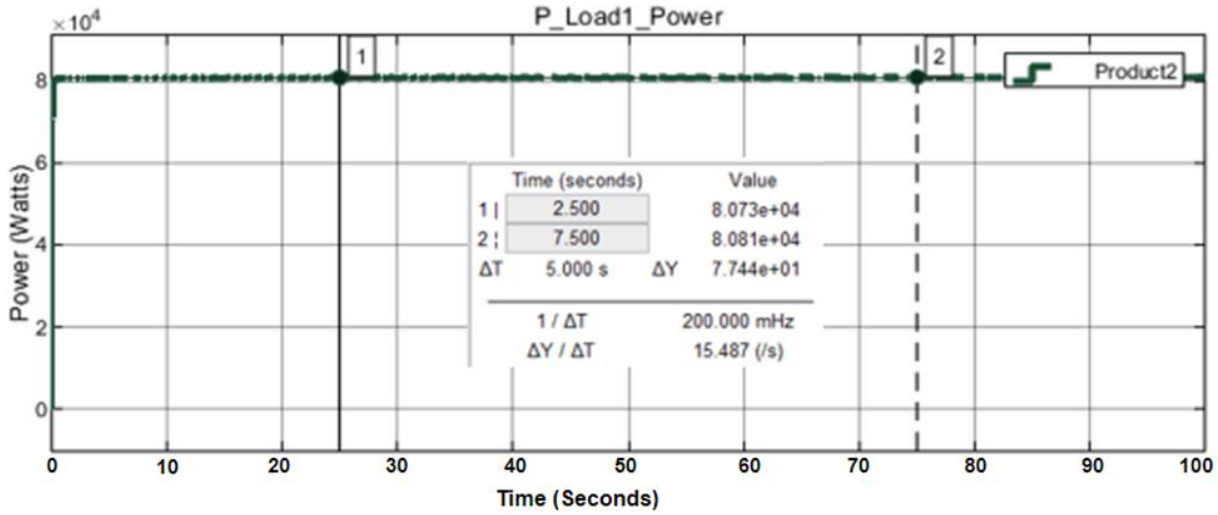


Figure 27: Input power to primary load (Load 1)

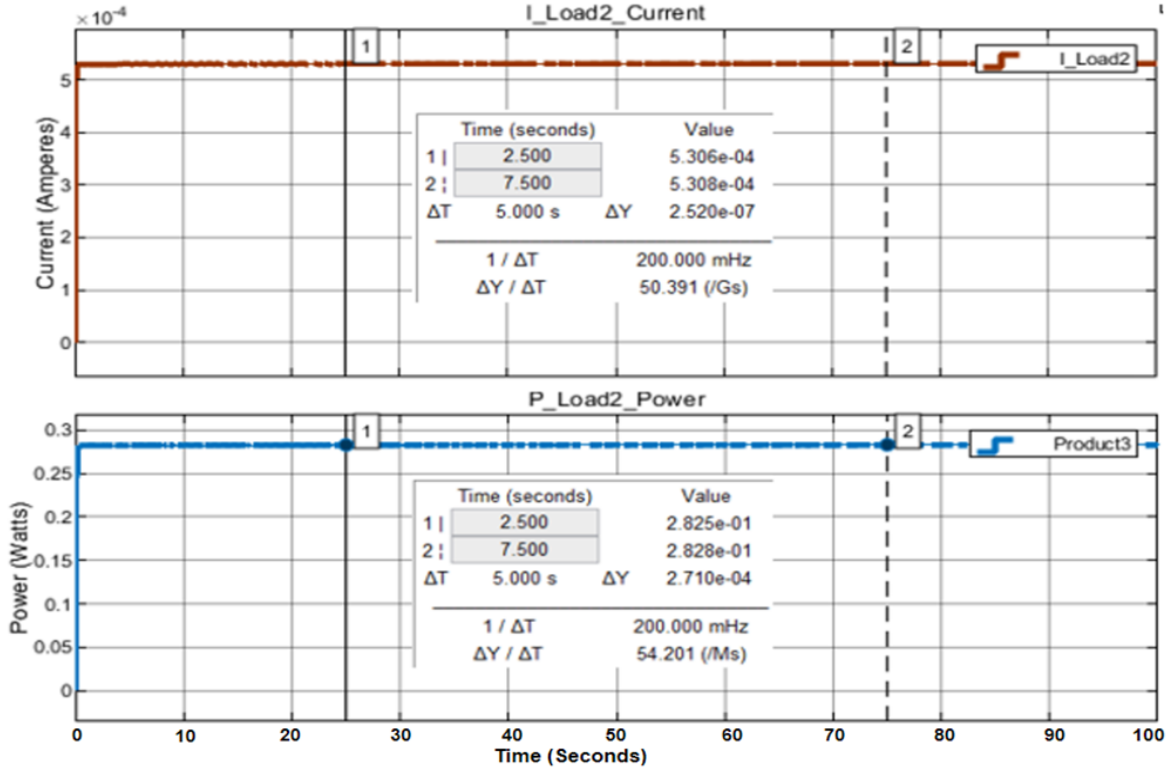


Figure 28: Current and power

8. Dataset H: Scenario 2 (where $P_{PV} = L_{DT}$)

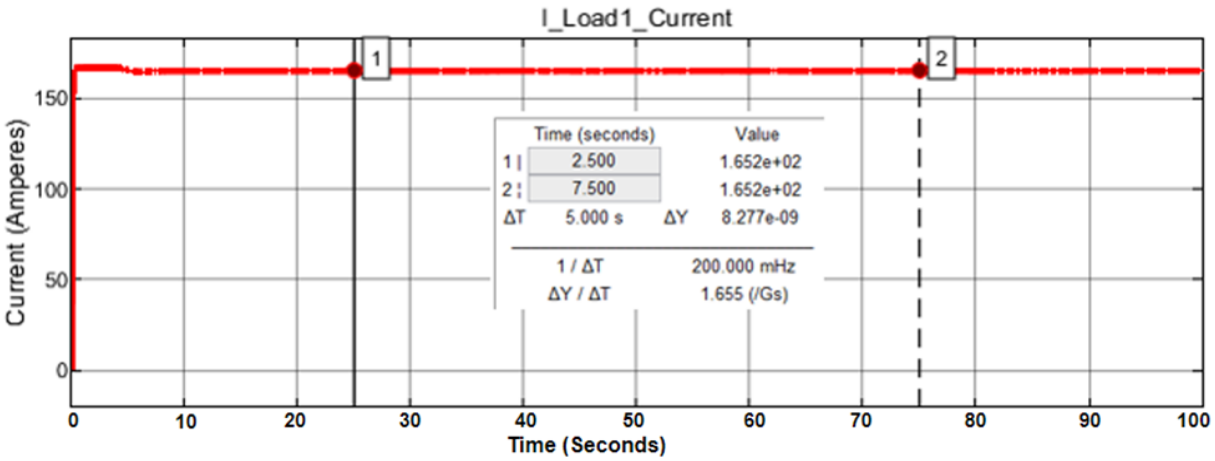


Figure 29: Current flowing through primary load (Load 1)

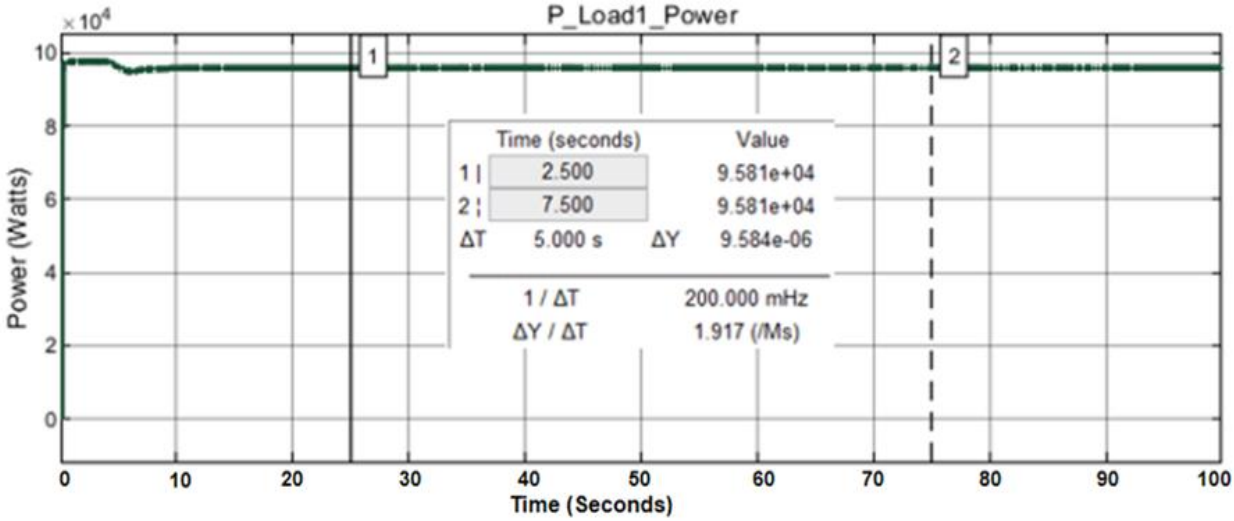


Figure 30: Power input to primary load 1

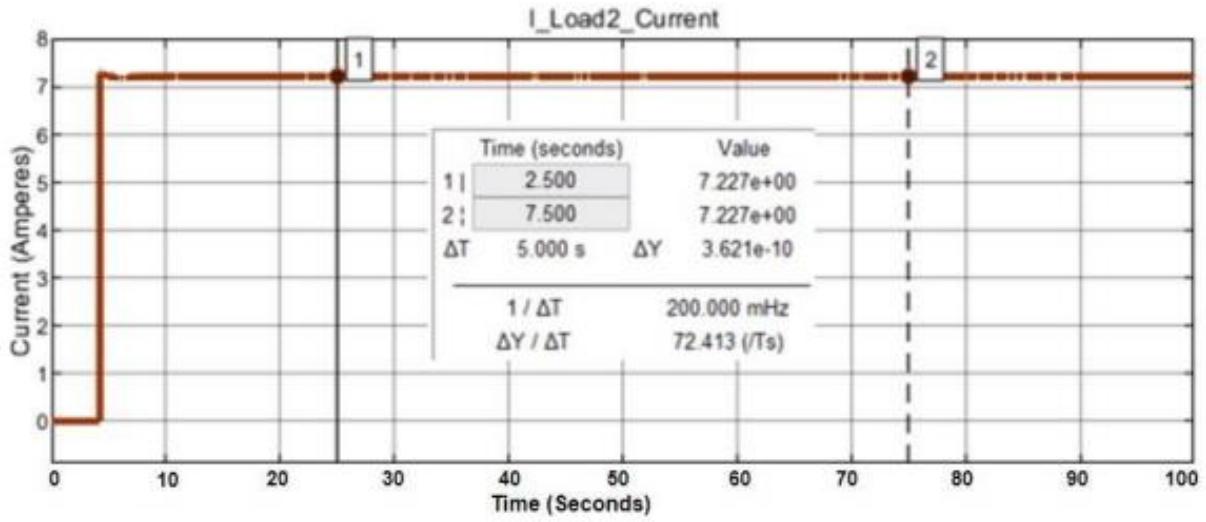


Figure 31: Current flowing through secondary load (Load 2)

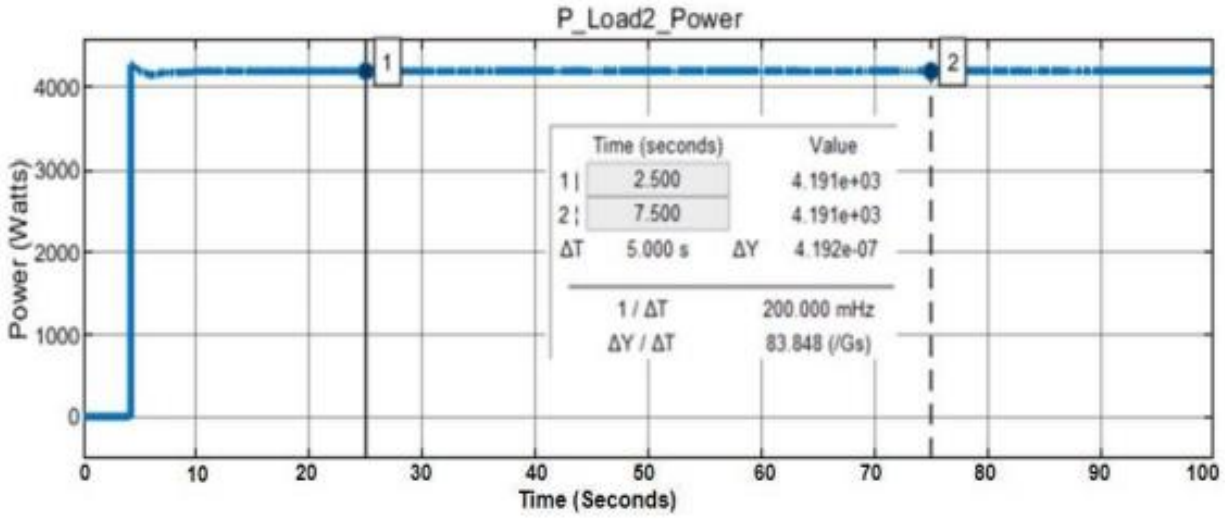


Figure 32: Input power to secondary load (Load 2)

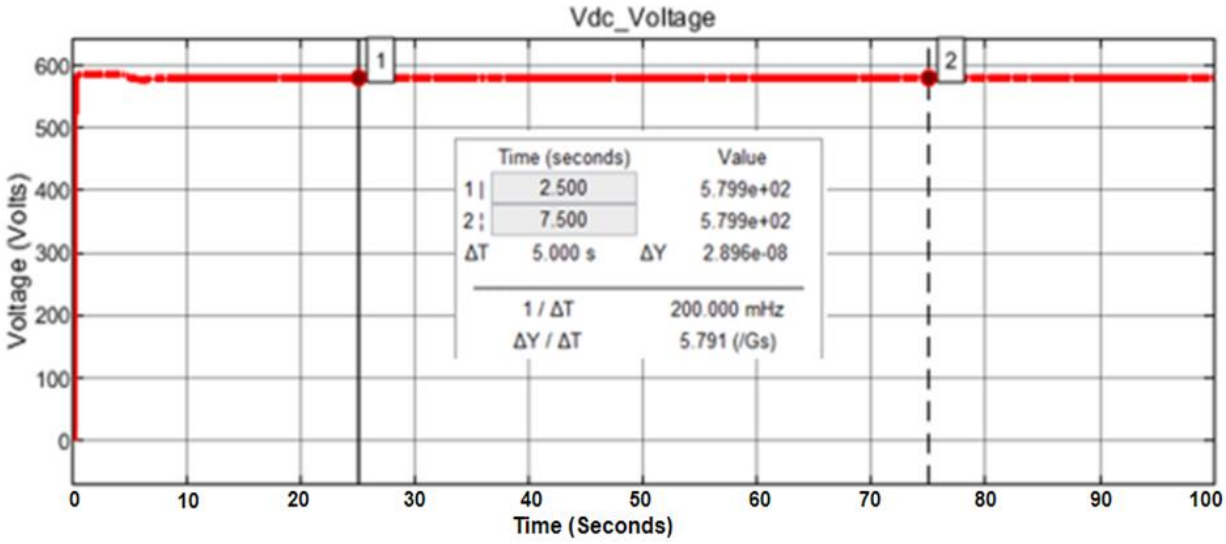


Figure 33: DC voltage across both loads

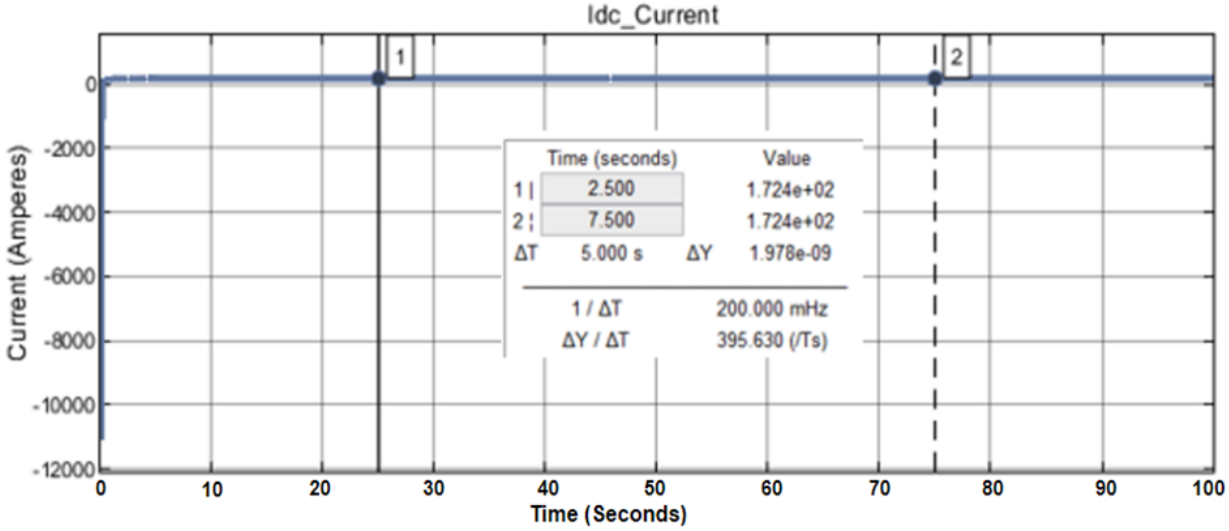


Figure 34: The supply current

9. Dataset I: Scenario 3 (where PPV < LDT)

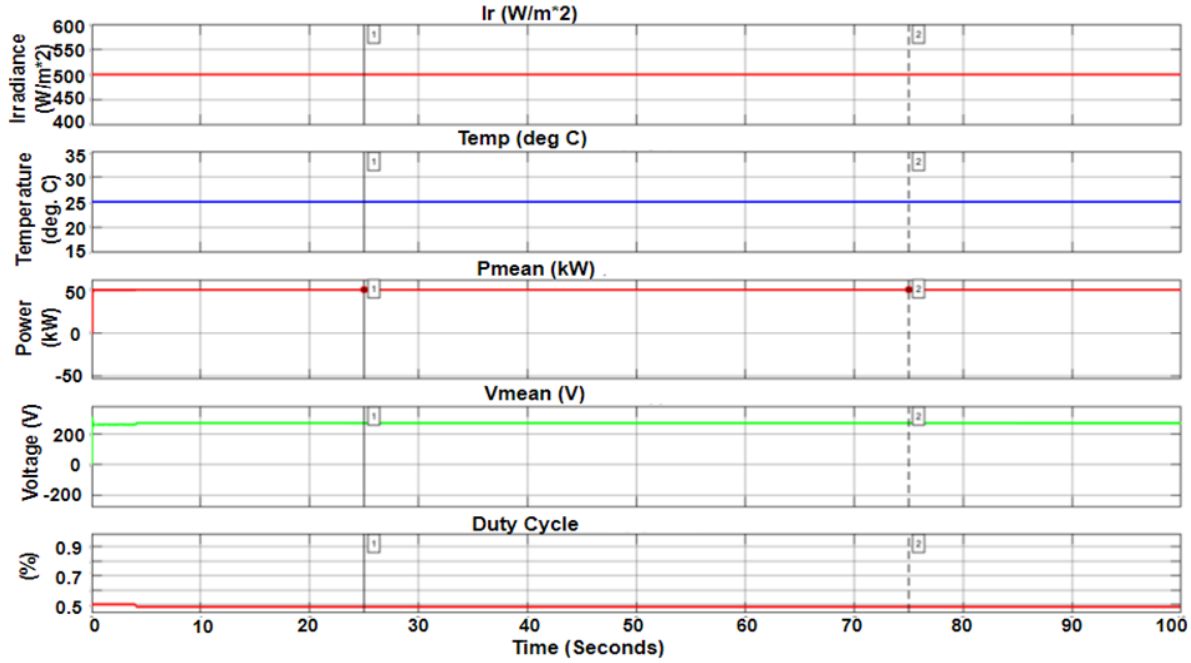


Figure 35: Solar PV parameters for case study 3

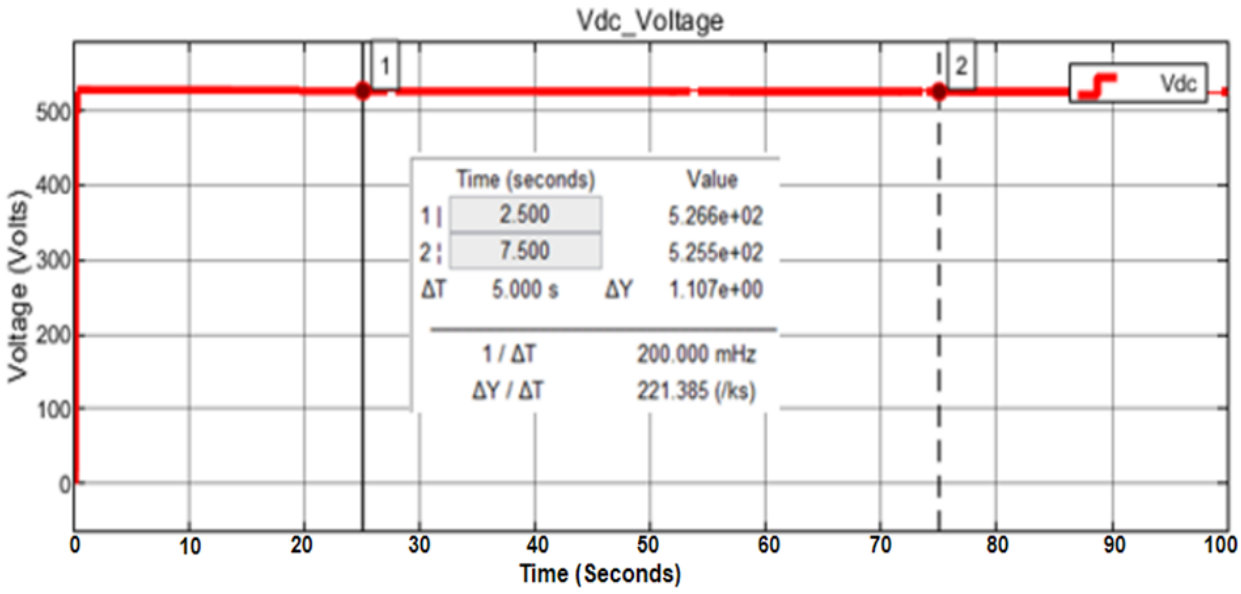


Figure 36: DC link voltage (Vdc)

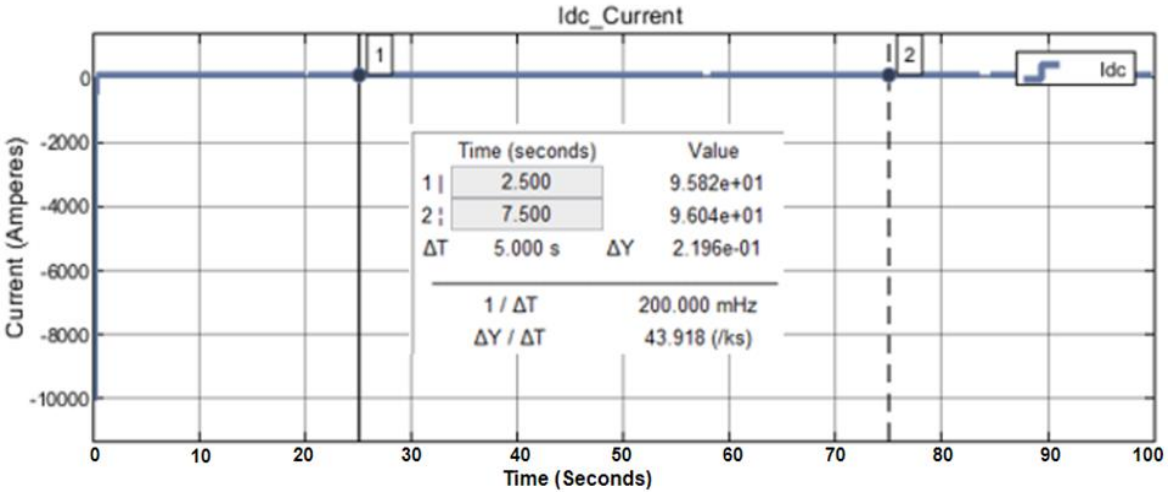


Figure 37: Input current

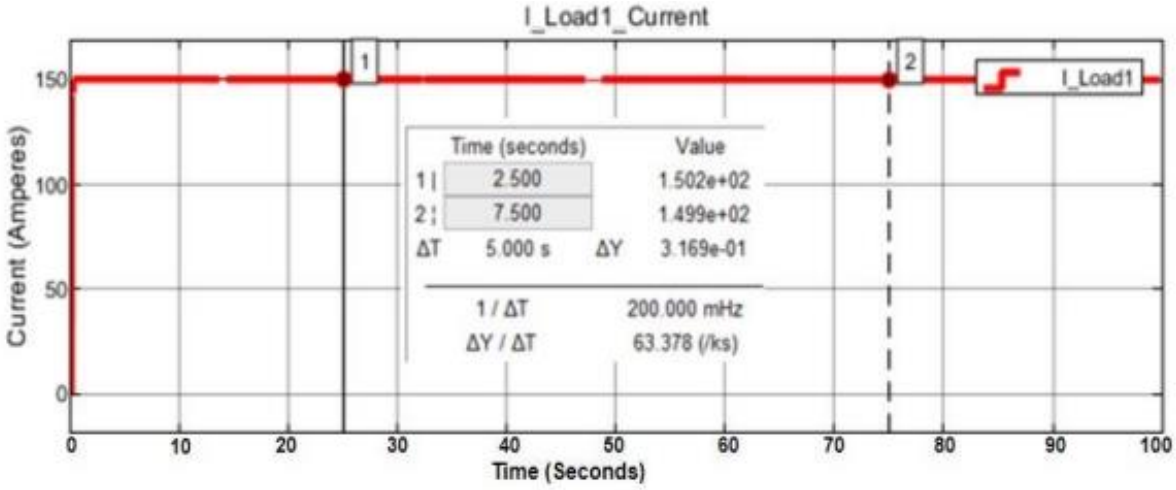


Figure 38: Current flowing through primary load (Load 1)

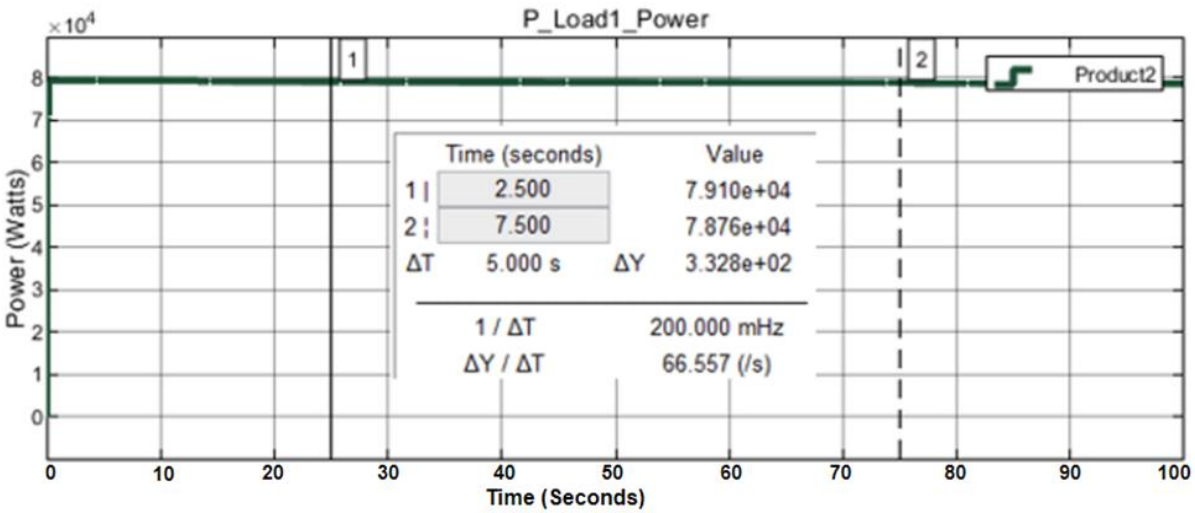


Figure 39: Power supply to primary load (Load 1)

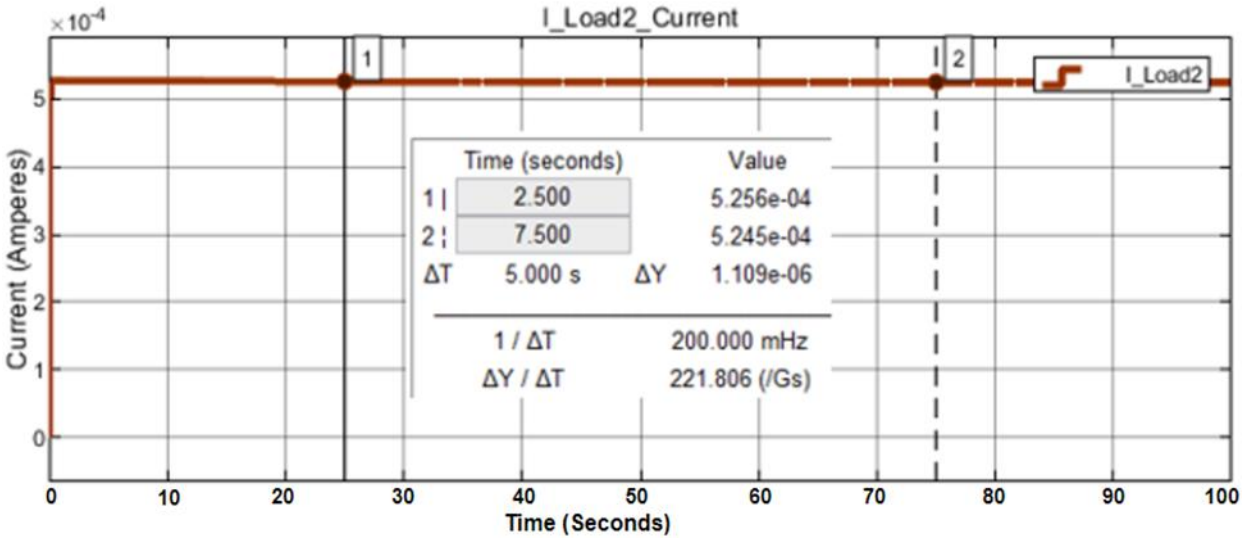


Figure 40: Current flowing through secondary load (Load 2)

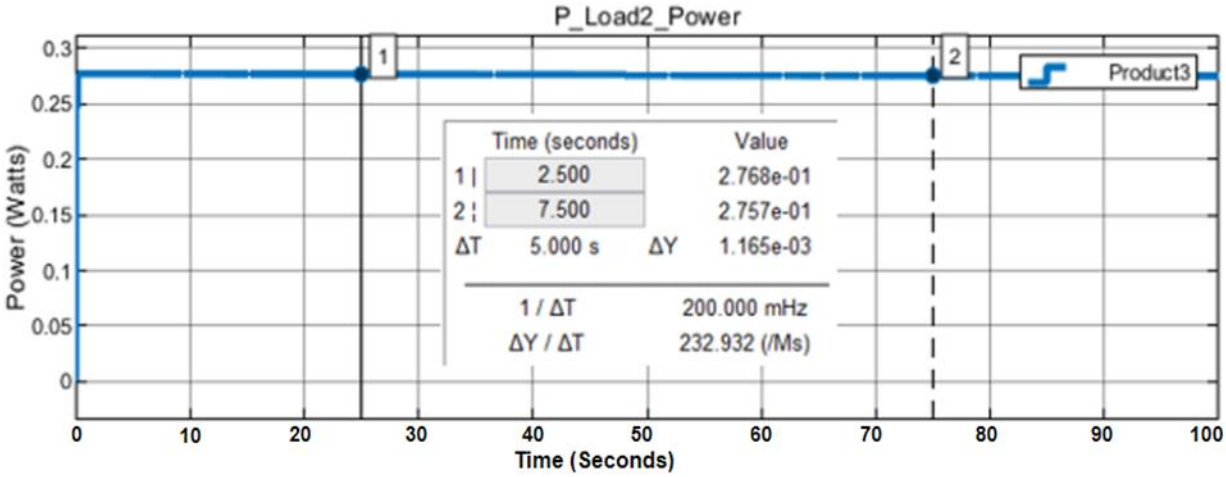
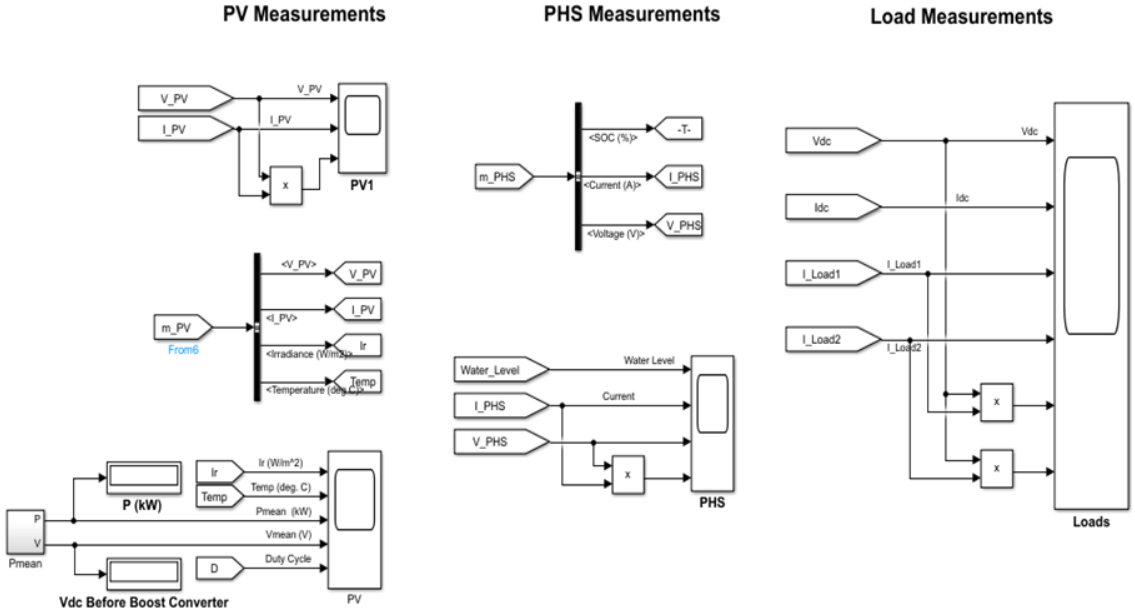


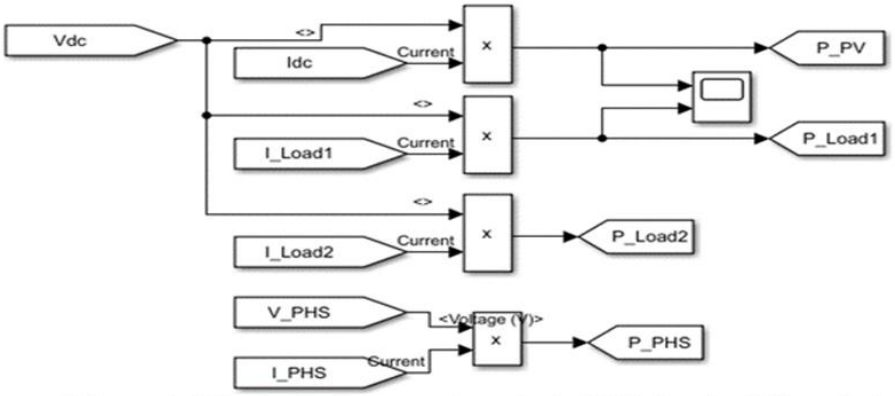
Figure 41: Input power to secondary load (Load 2)

APPENDICES

Appendix 1: DCMG system measurements



Appendix 2: DCMG system control variables and set conditions.



If PV power is higher than load1 power and water level of PHP is less than 98% supplies load1 and run the PHS as a motor to fill the upper reservoir (Irradiance=1000 and Water level less than 98%)

If PV power is higher than load1 power and water level is greater than or equal to 98% supplies load1 and load2 (irradiance=1000 and Water level=98%)

if PV power is equal equal to load1 supplies load 1 supplies Load1 only

if PV power is lesser than load1 power and water level is higher than or equal to 10% supplies load1 from both PV and PHP (Irradiance=500)

Else PV and PHP are off