Performance Evaluation of a Photovoltaic System Using Solar Reflectors and PID-Controlled Cuk Converter

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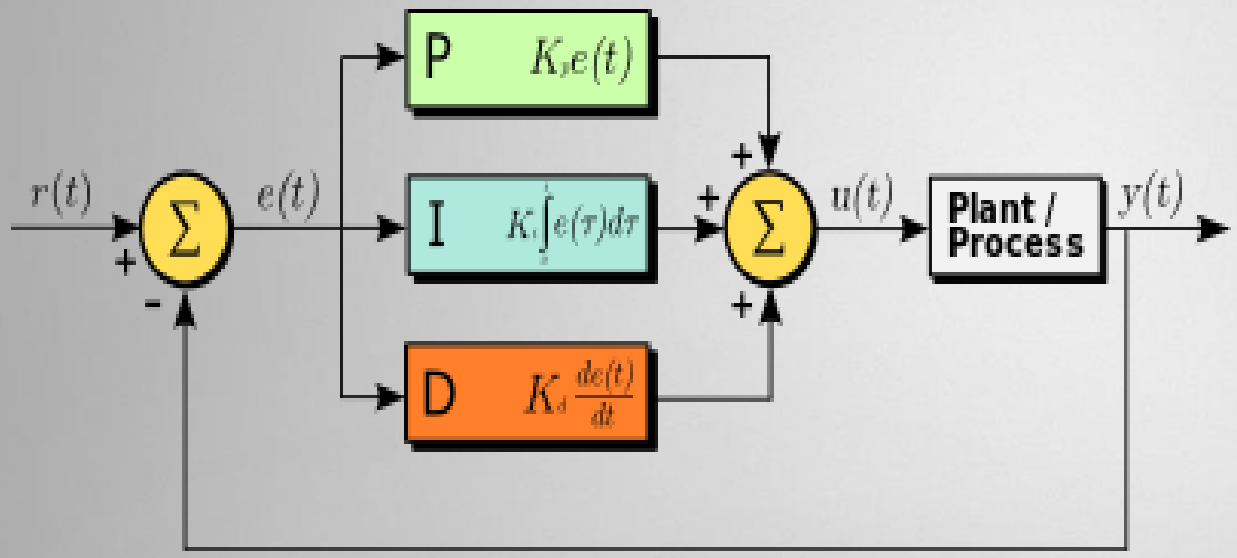
Solar Reflectors

- Used to increase the output energy conversion of solar panel.
- Must be properly design to optimize the output of the solar panel

PID Controller



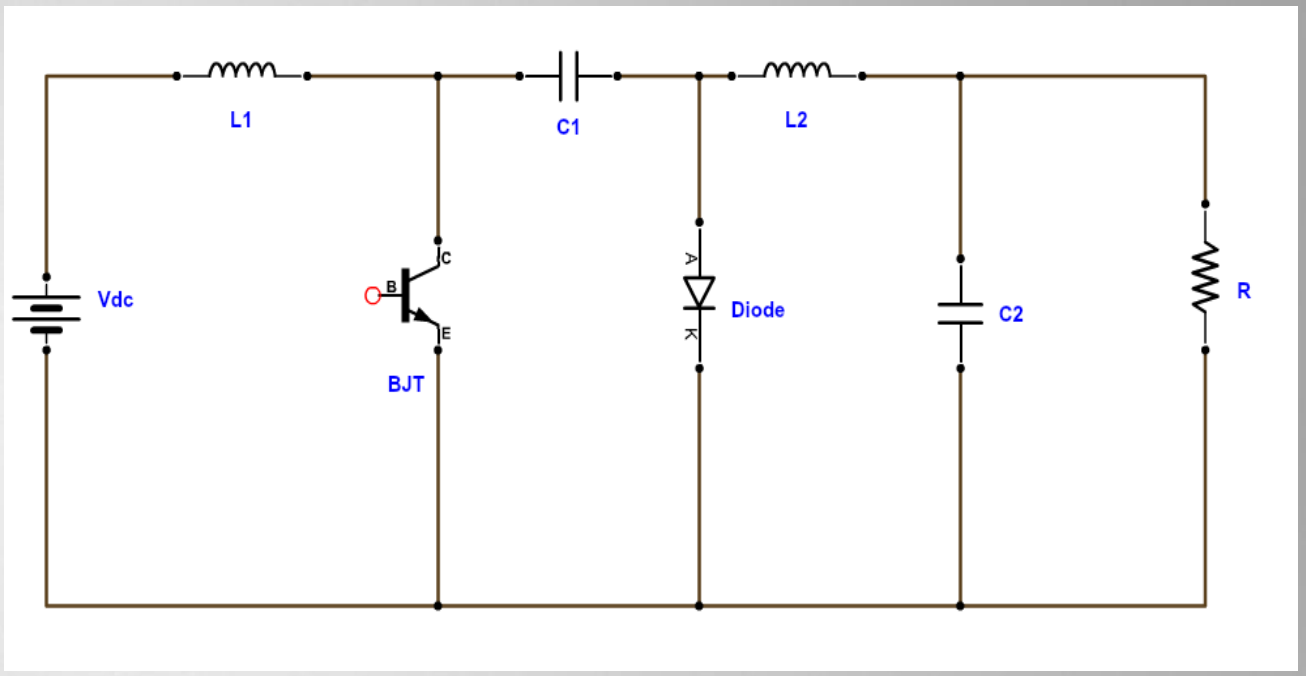
- It is a closed-loop control mechanism that can be utilized to regulate the generated (output) voltage or current of a circuit.
- It evaluates the error value (the difference between the desired setpoint value and measured output value) based on the equation:

$$a(t) = Kp\, e(t) + K_i \int_0^t e(t)dt + K_d \frac{de(t)}{dt}$$

http://readingrat.net/closed-loop-control-system-block-diagram/the-components-of-a-control-loop-control-guru/

Cuk converter

- Act as voltage/current transformer in DC application
- Cuk converter is buck-boost dc-dc converter that has the highest efficiency and fastest frequency response among the known dc-dc converters.




WHY?
why?
Why?
WHY?
Why?

PV Systems Primary Issues

1

A typical PV system set-up can offer no more than **15% average efficiency** due to rapid changes in solar irradiance, temperatures, and other input parameters.

2

Several occurring transients may **compromise the performance and life-span of a PV system**

3

Traditional methods of MPPT are too **complicated and provide erroneous pulse signal** to a dc-dc converter

WHAT WE DO?

Objective & Action Plans

- Design and simulate a PV system with Cuk converter and PID controller to attain a 20% maximum efficiency.

  a) Design a PV system and a Cuk converter using Maltab

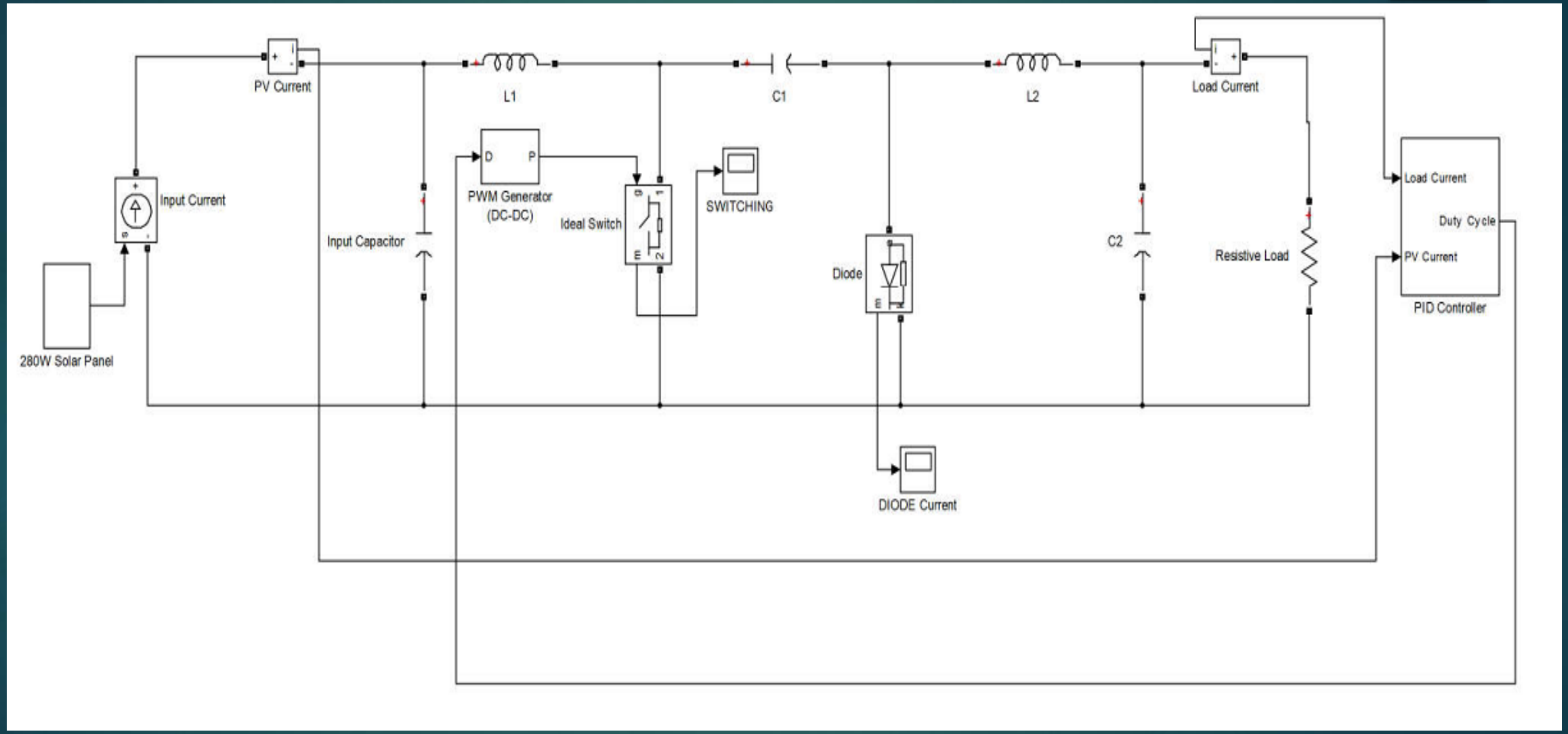
  b) Design a PID controller


SO
WHAT?

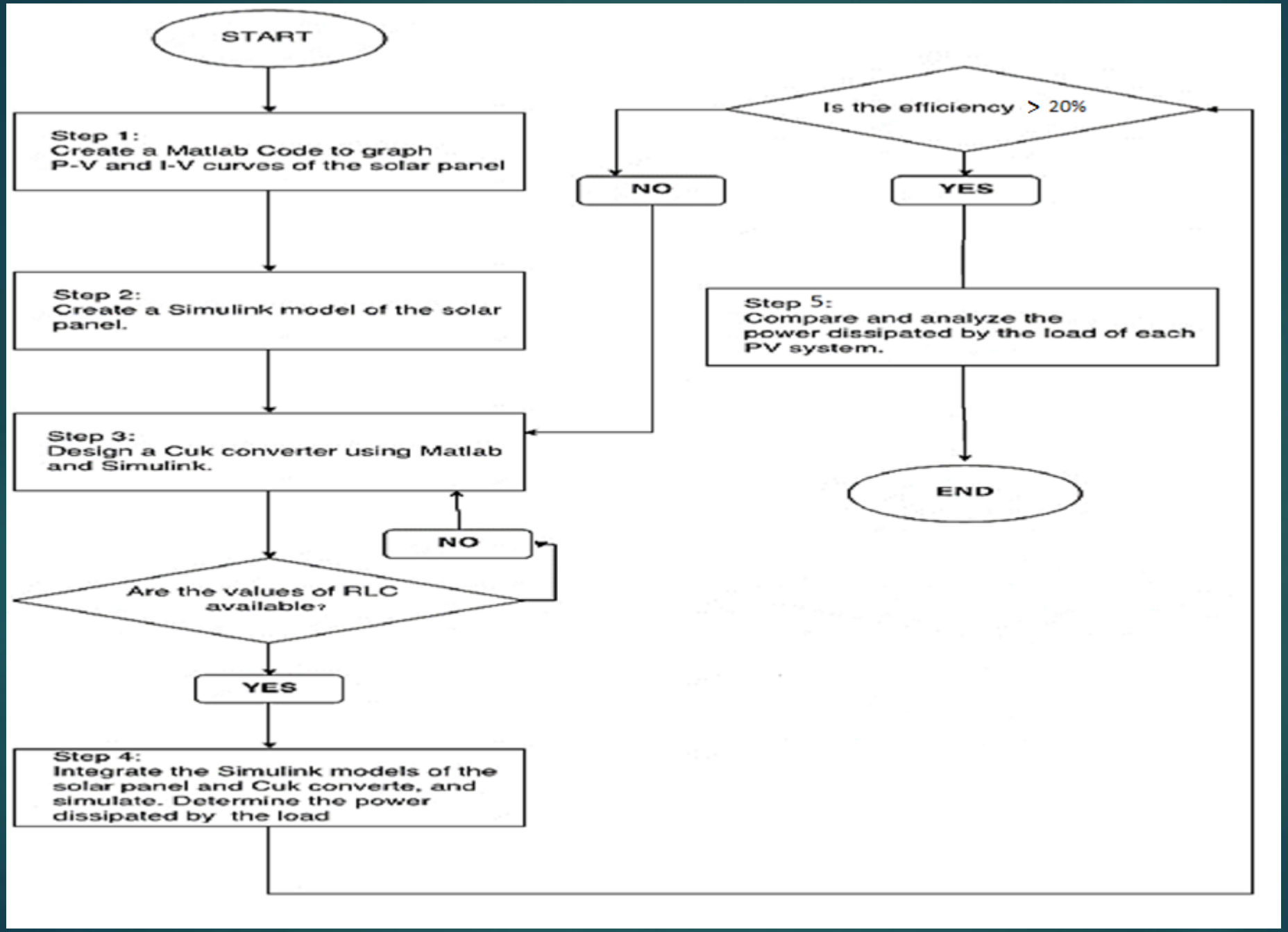
Significance of the study

- **Minimal current and voltage ripples**
  - **Reduce electrical stress to the storage system and power inverter**
- **High operation efficiency**

Theoretical framework

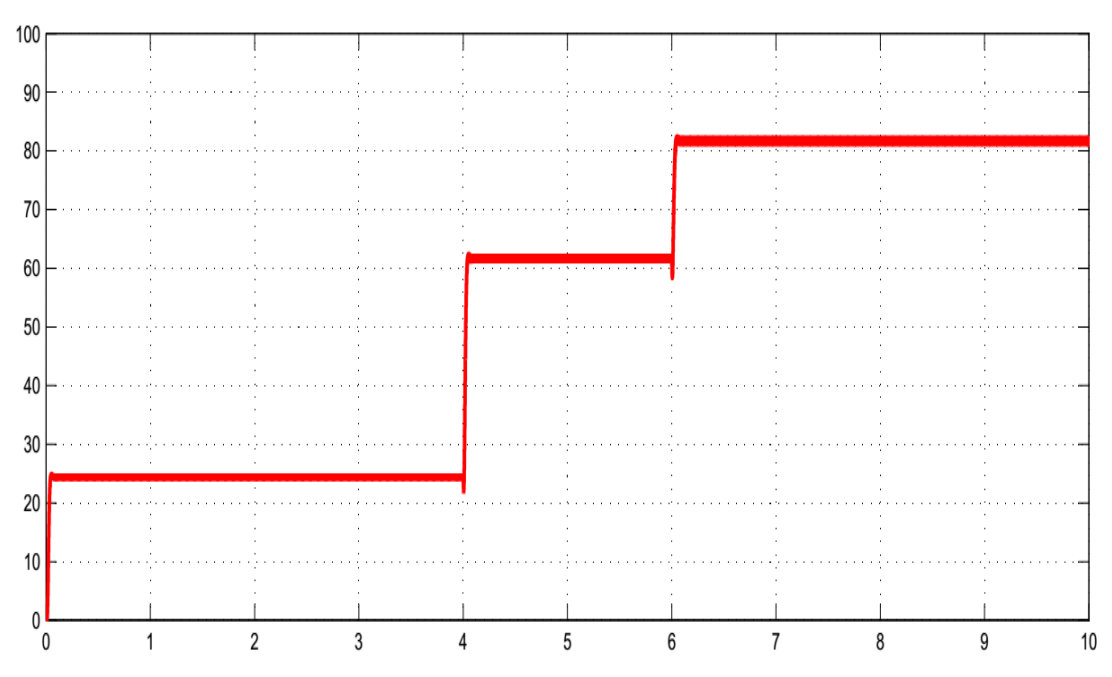


Methodology



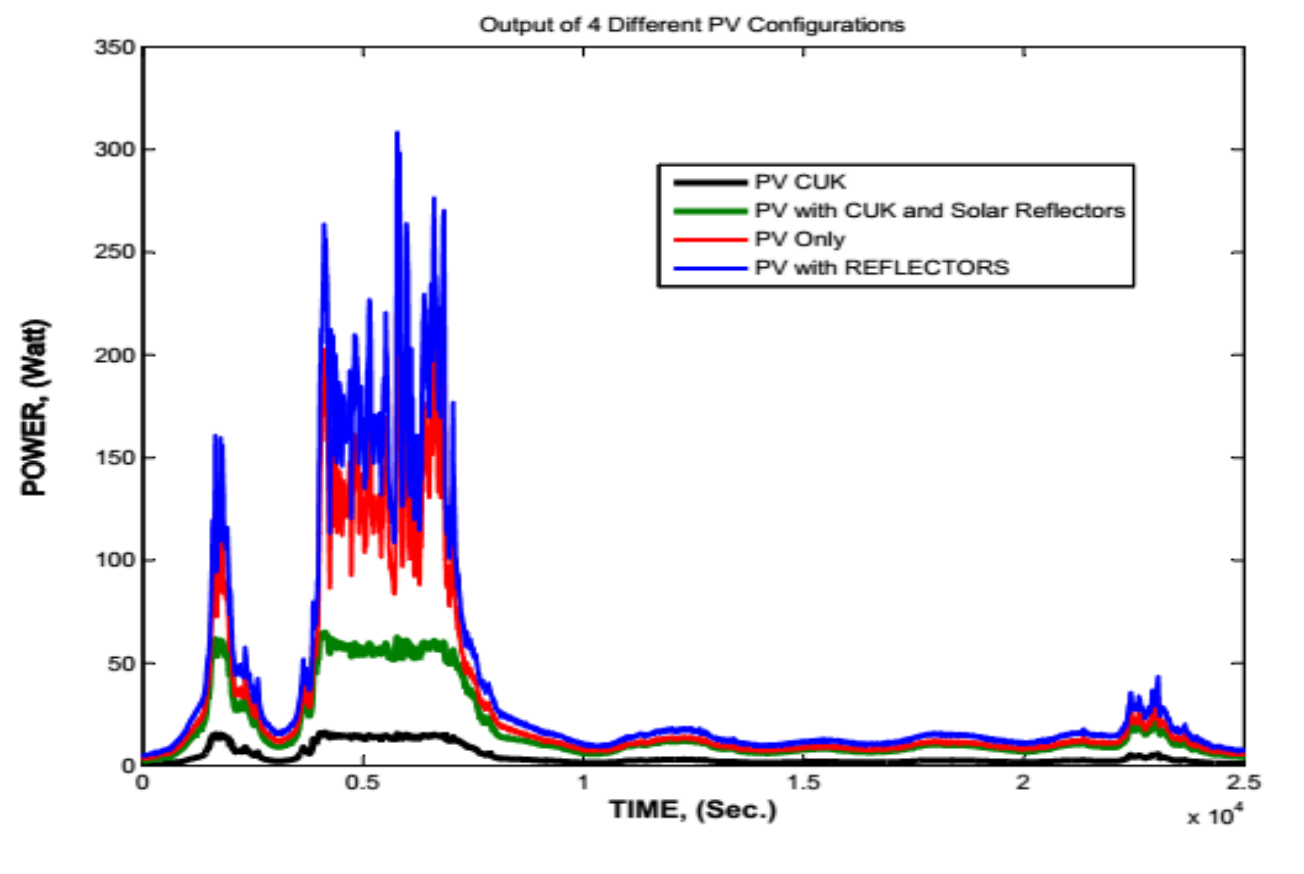
Results: Matlab Simulation

With non-lossloess power pource



Duty Cycle (%)	Input Power (W), Pi	Output Power (W) Po	Efficiency (%) Po/Pi
64.69	100	25	25
55.47	150	61.5	41
51.85	180	82	45

Results: Experimental Set-up



Parameter	PV FIXED	PV CUK CONVERTER	PV WITH REFLECTORS	PV W/ CUK CONVERTER & REFLECTORS
Output Power (W), Po	123.7	15.132	308.45	60.84
Input Power (W), Pi	836.93	836.93	836.93	836.93
% Maximum Efficiency (Po/Pi)	14.78	1.8	36.87	7.27

Conclusions

1. The designed PV system has the capability to maintain a stable desired output.
2. The Matlab simulations reveal that that due to the input resistance of the power source, the output is compromised.
3. the PID controller is no longer tuned when the input resistance is connected to the source


WHAT
NEXT ?

Recommendations

- **redesign further a robust Cuk converter by implementing an adaptive algorithms for tuning the PID controller including the Cuk converter to mitigate switching loss caused by the transistor.**

- **to implement a Sun tracking system to adjust the inclination of solar reflectors**


THANK YOU