Inverting loadshedding with Solar PV and Battery Storage

Dr. Arnold J Rix

23 May 2024

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Inverting loadshedding with Solar PV and Battery Storage

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Department of Electrical and Electronic Engineering
Stellenbosch University
South Africa

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Inverting loadshedding with Solar PV and Battery Storage

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- Introduction
- PV system research at Stellenbosch
  - Modelling
  - Measurement & Development
  - Forecasting
- Hybrid systems research
- Inverting loadshedding – PV & batteries
  - Terminology – inverter, power and energy
  - Determine your load
  - Sizing your battery for loadshedding
  - Generate your own power with PV

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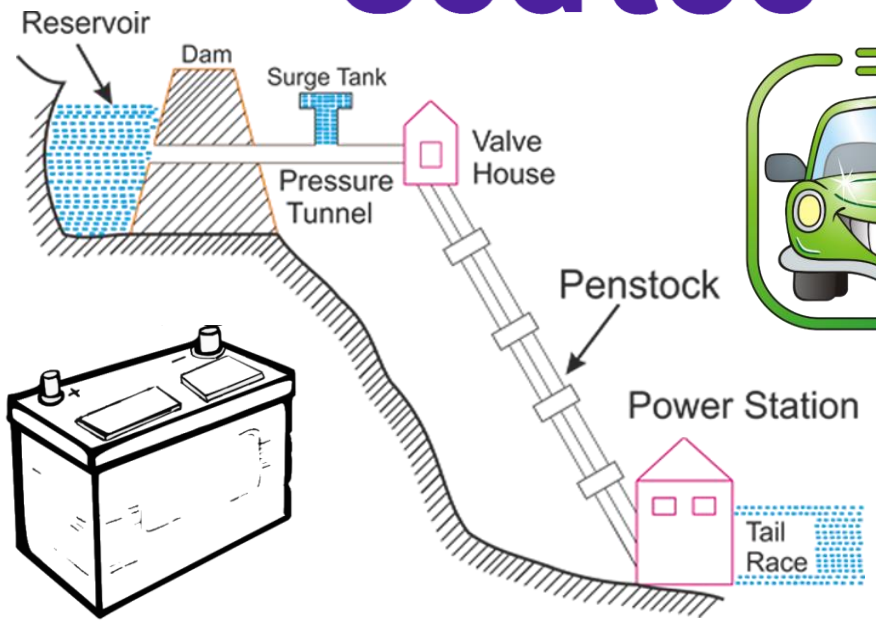
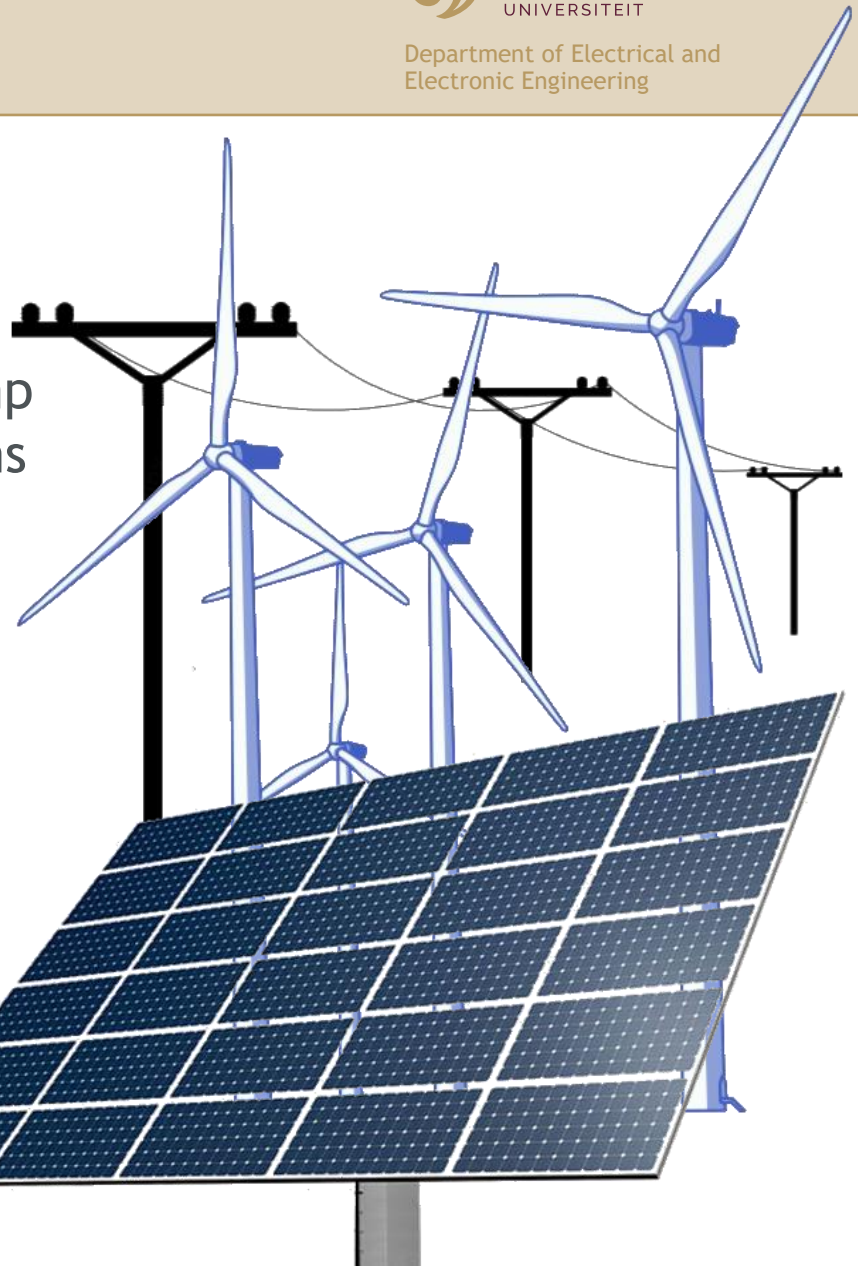
2004 B.Eng at University of Stellenbosch
2011 PhD at University of Stellenbosch
2011 Project Engineer / Manager at I-Wec
2013 Project Development Manager at Gestamp
2015 Scatec Solar chair in photovoltaic systems
to present Scatec





Introduction

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Training sought-after graduate students through industry relevant research projects while providing training and consulting services to the photovoltaic industry.

Train students

Research

Industry support

PV system research at Stellenbosch

Modelling PV Systems

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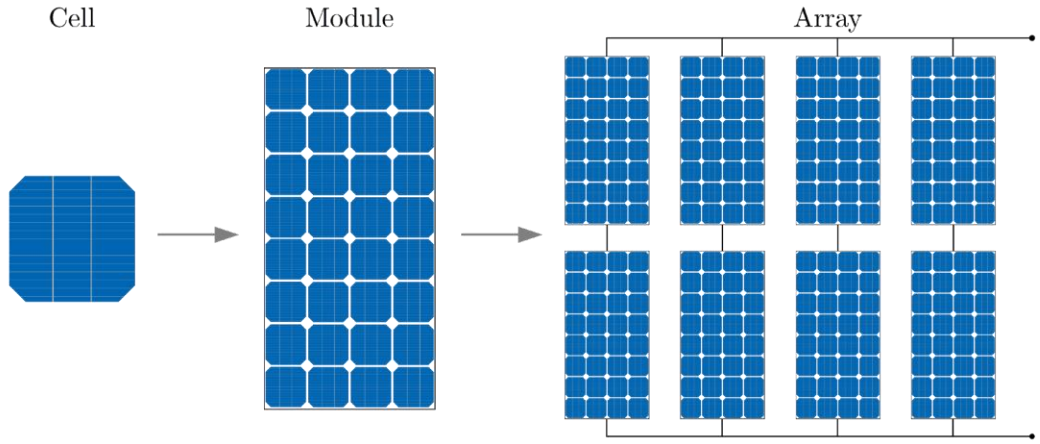

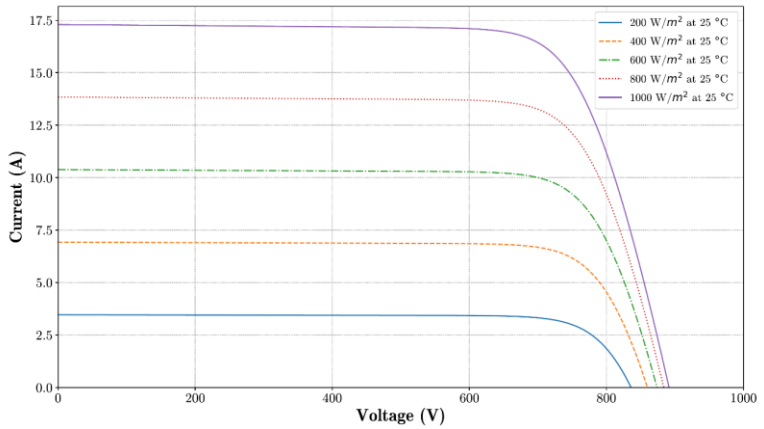

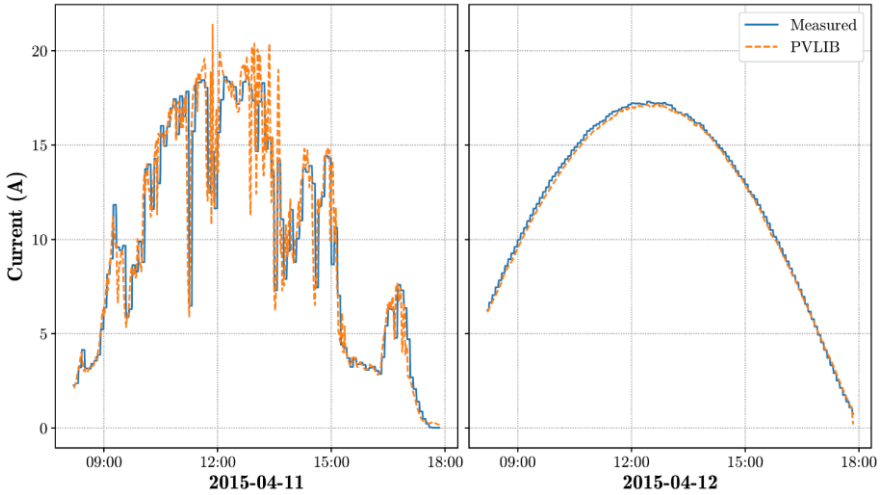

PV system research at Stellenbosch

Modelling PV Systems

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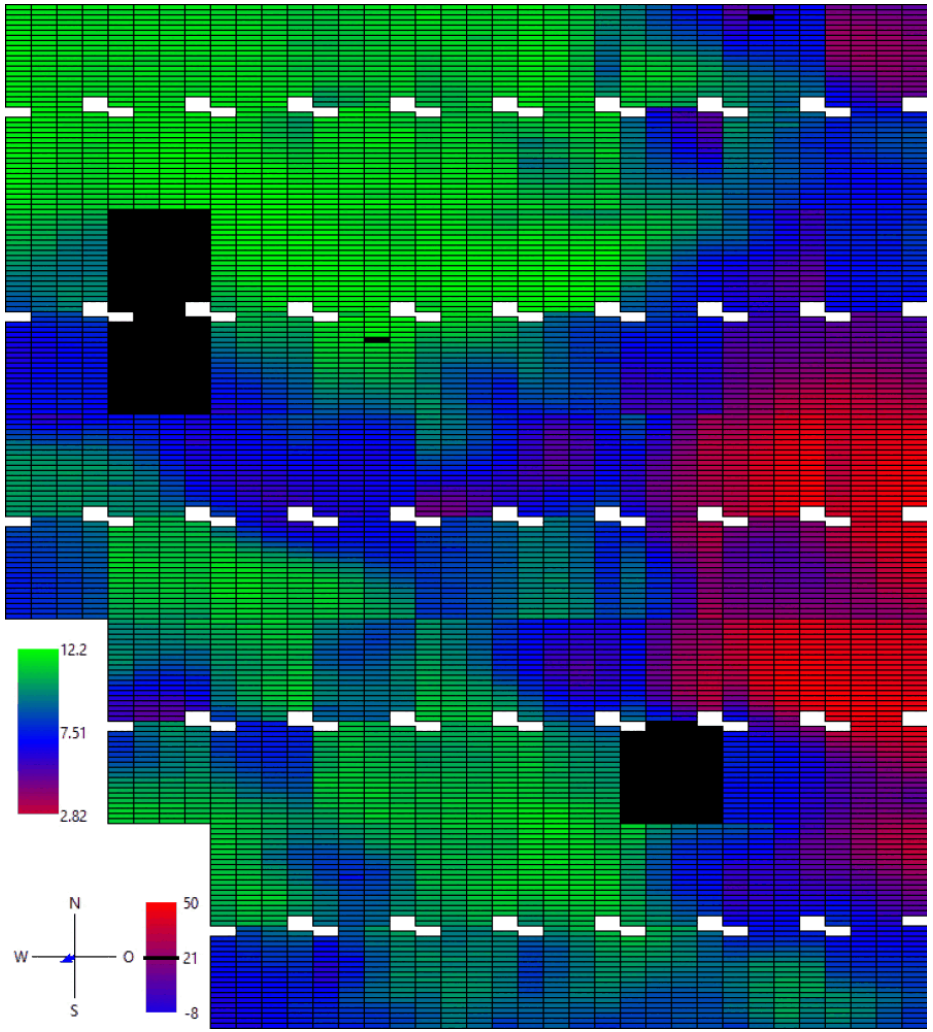

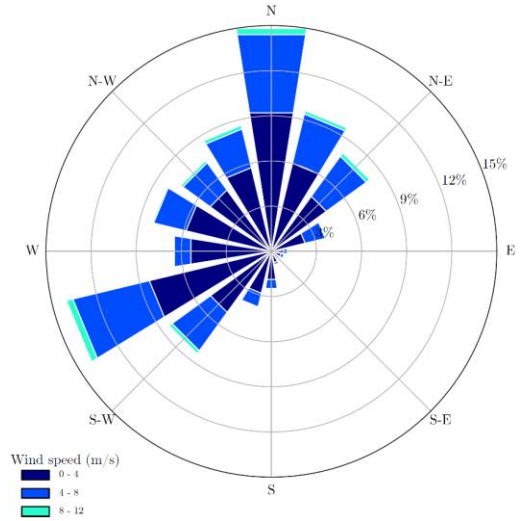

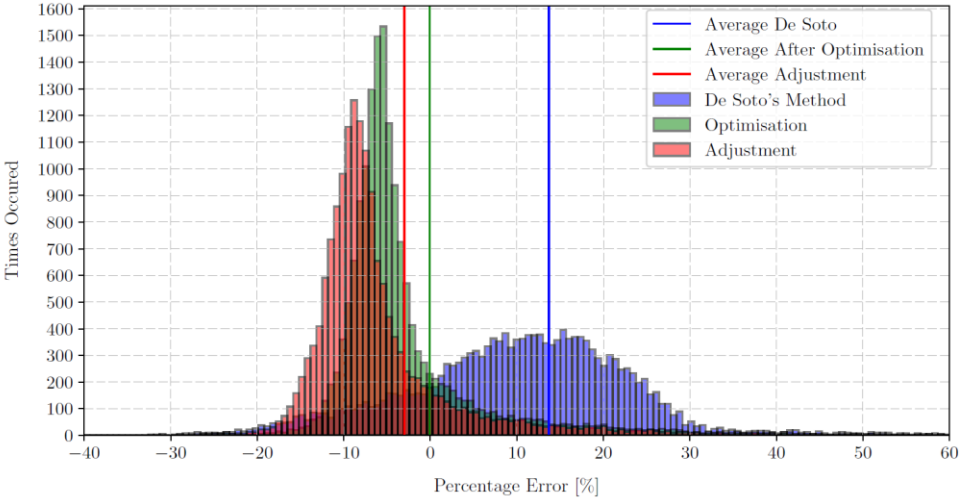

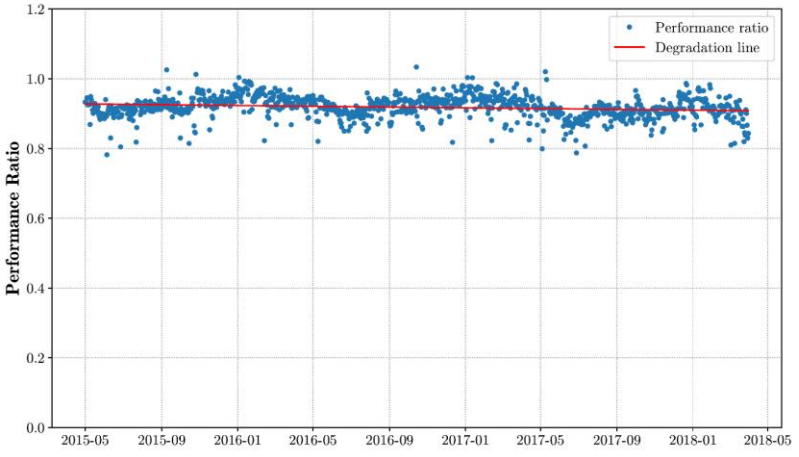

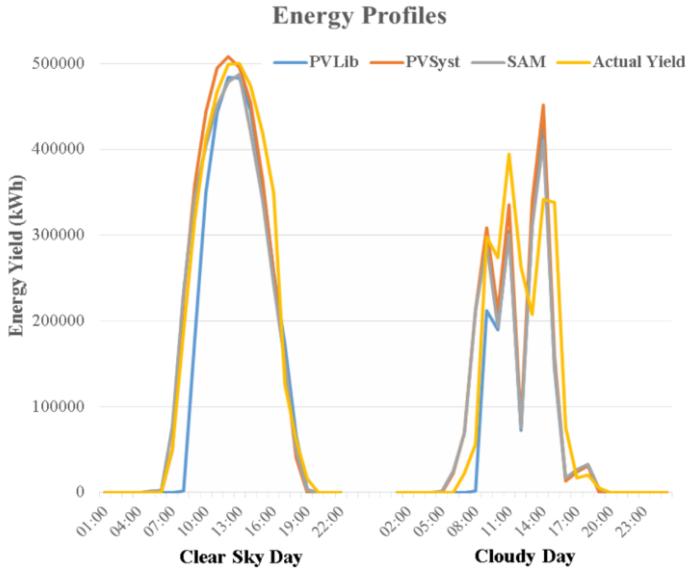

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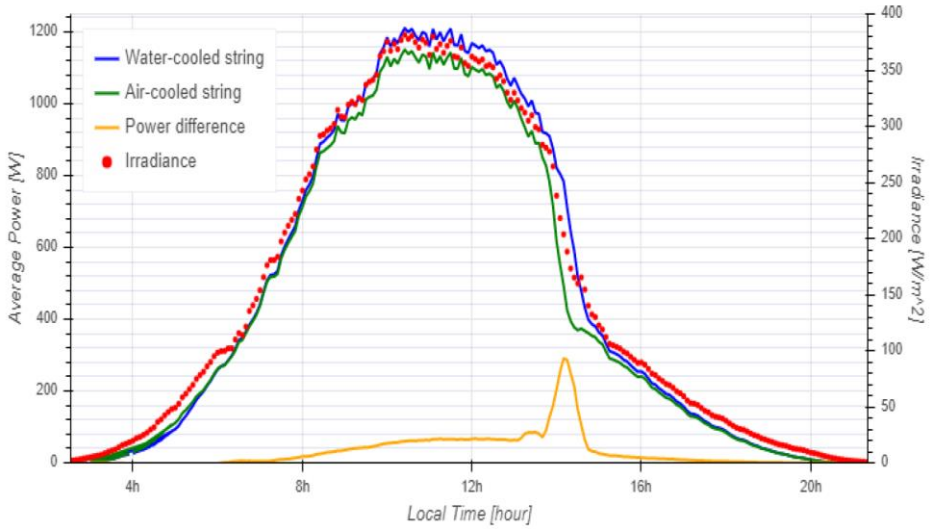

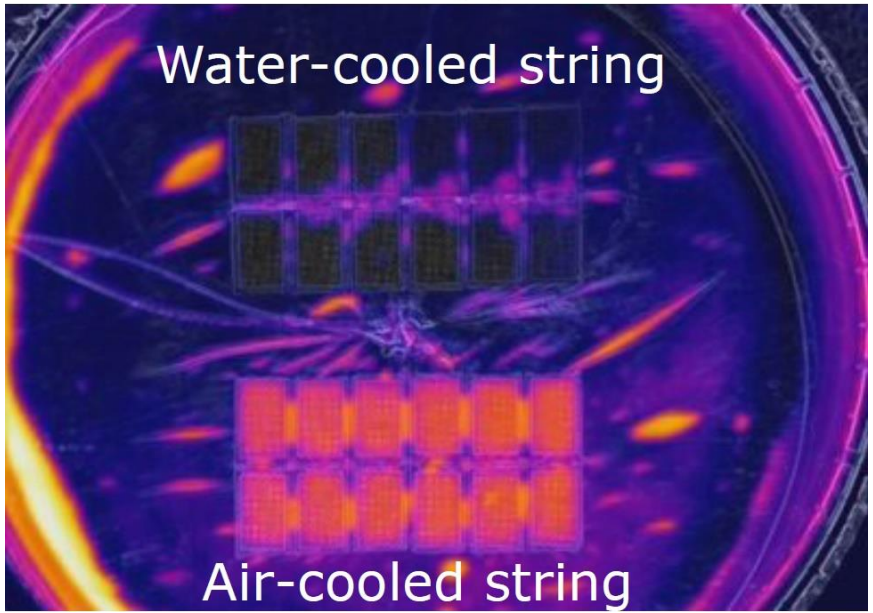

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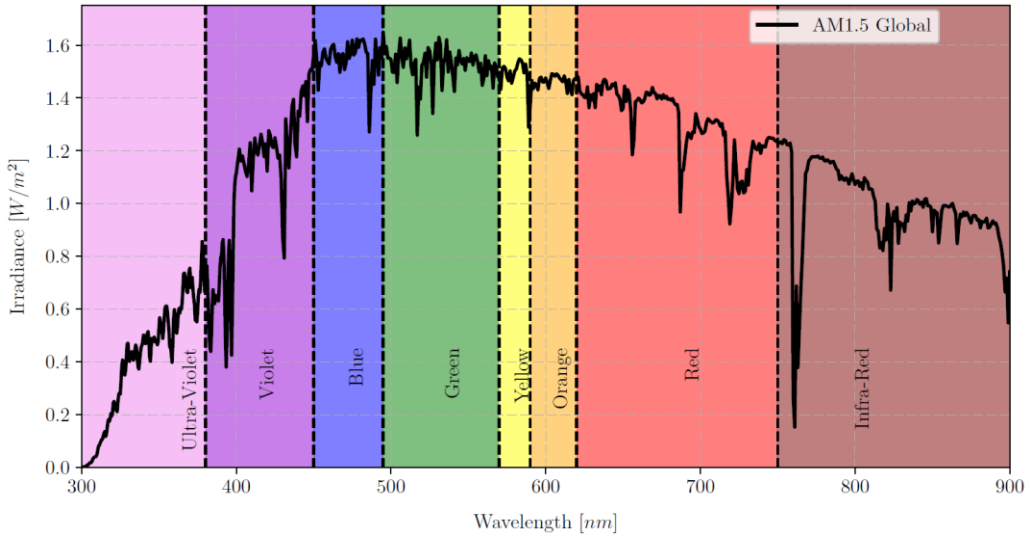

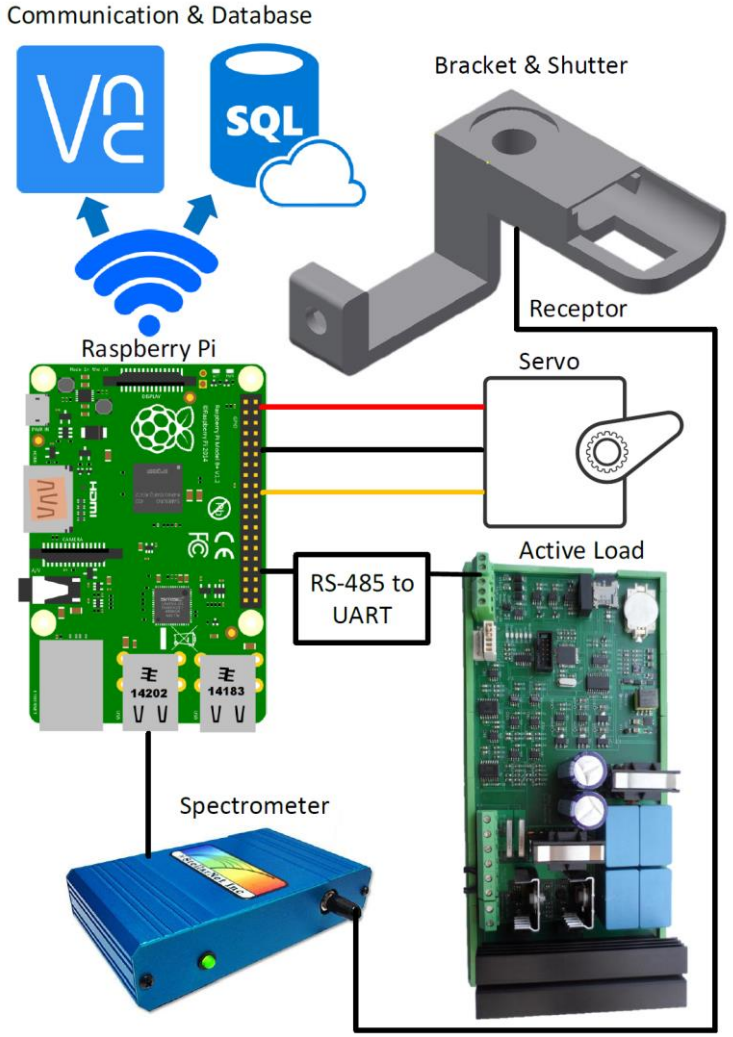

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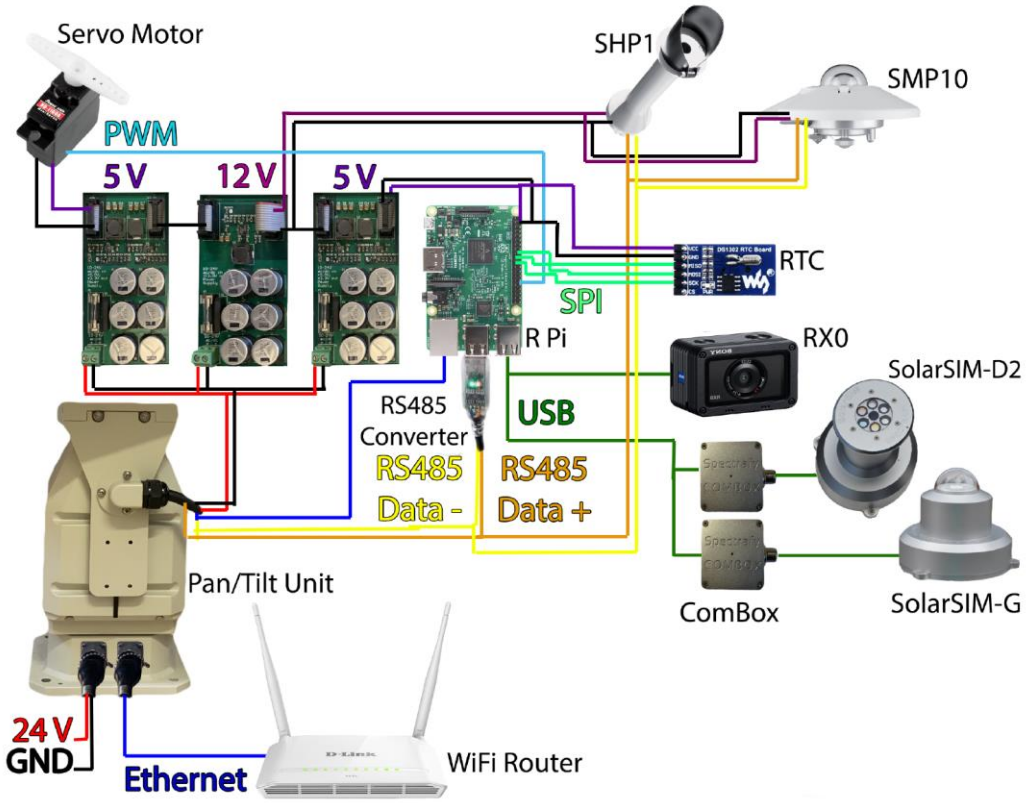

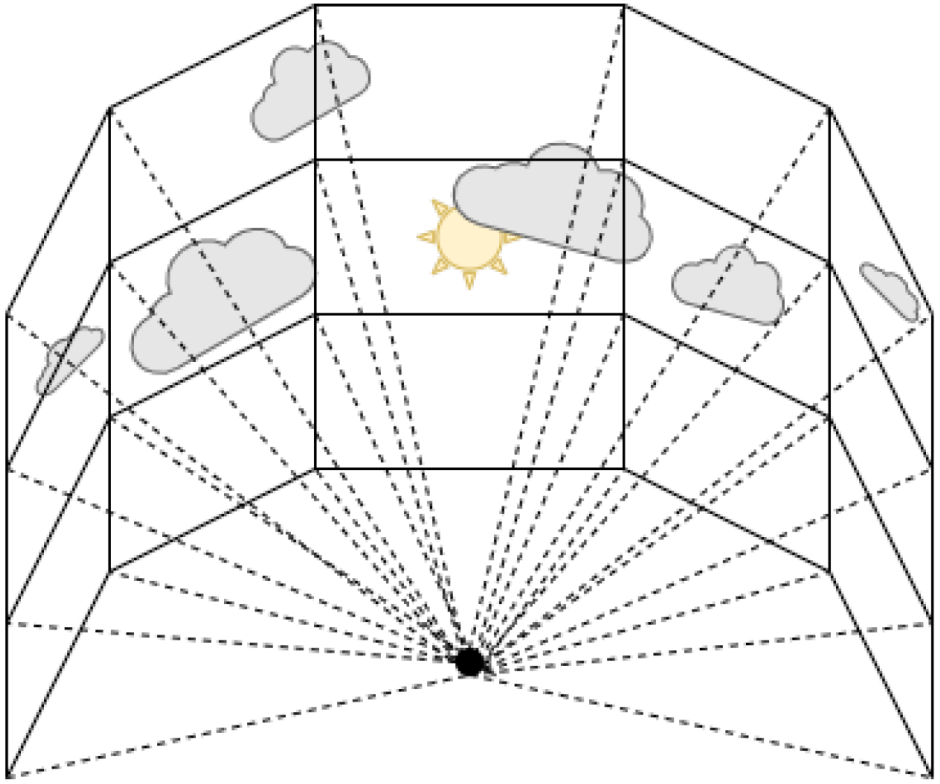

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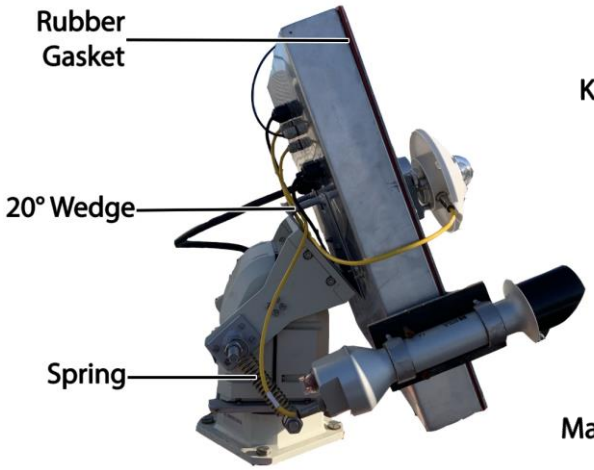
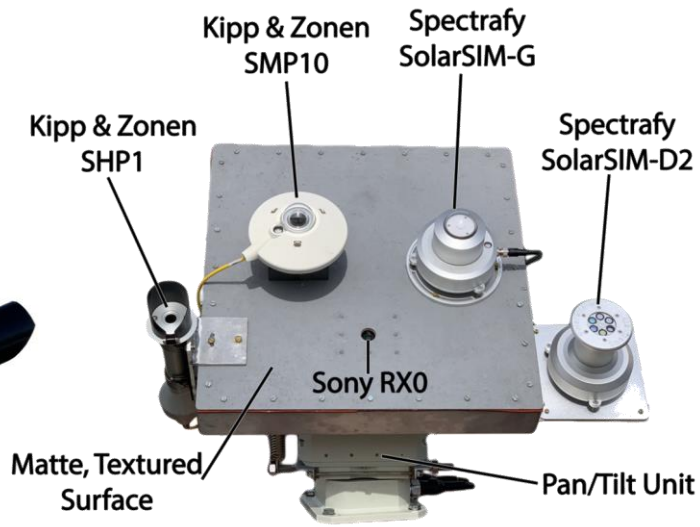
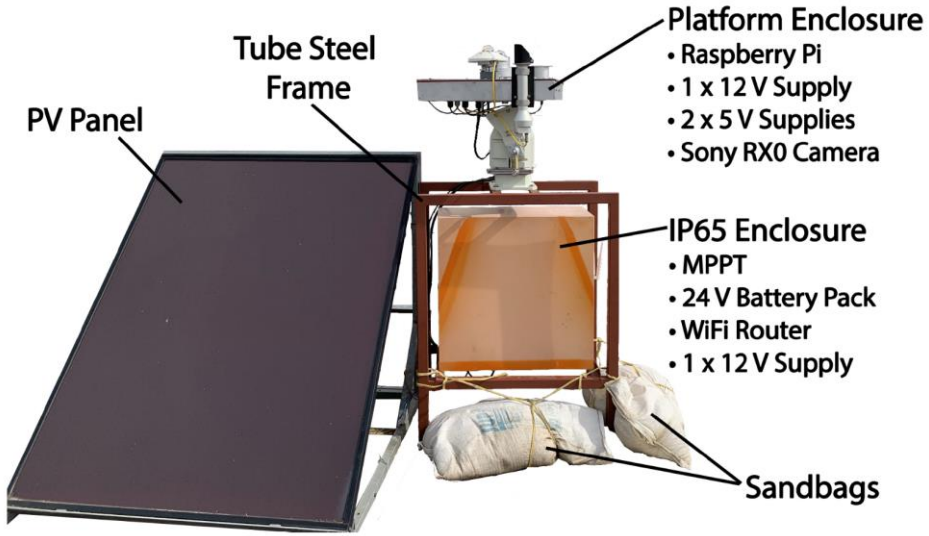
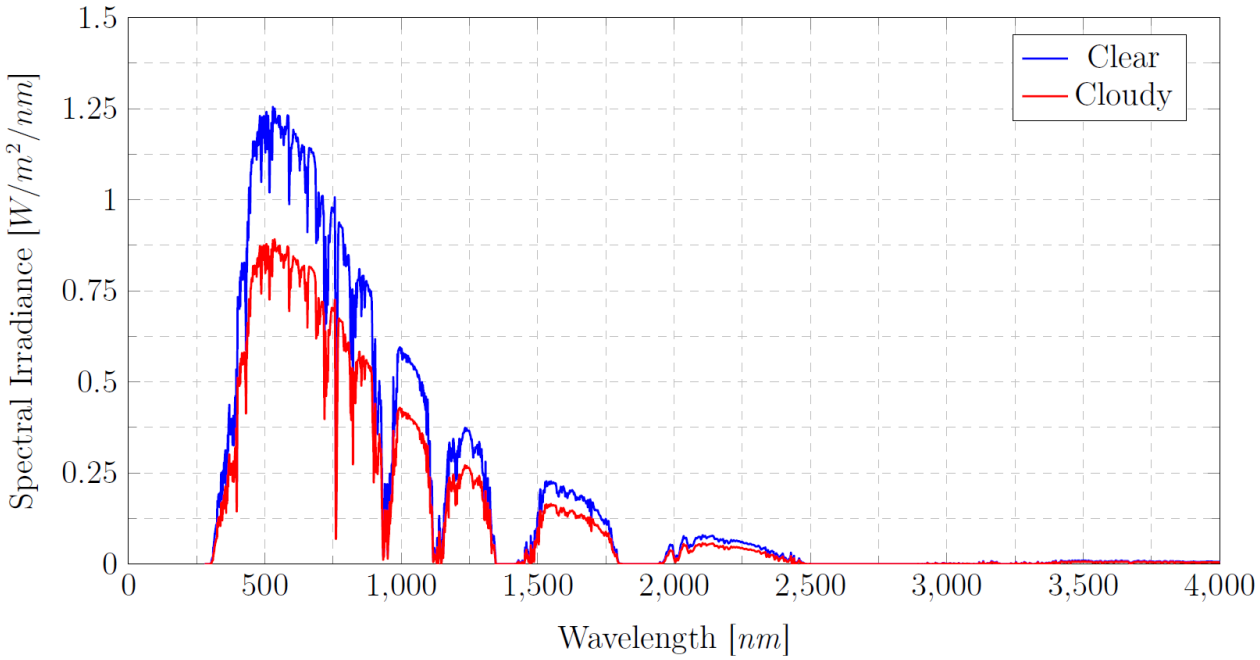






(a) Sky on 12/02/2021 at 09:24.

(b) Sky on 12/02/2021 at 09:44.



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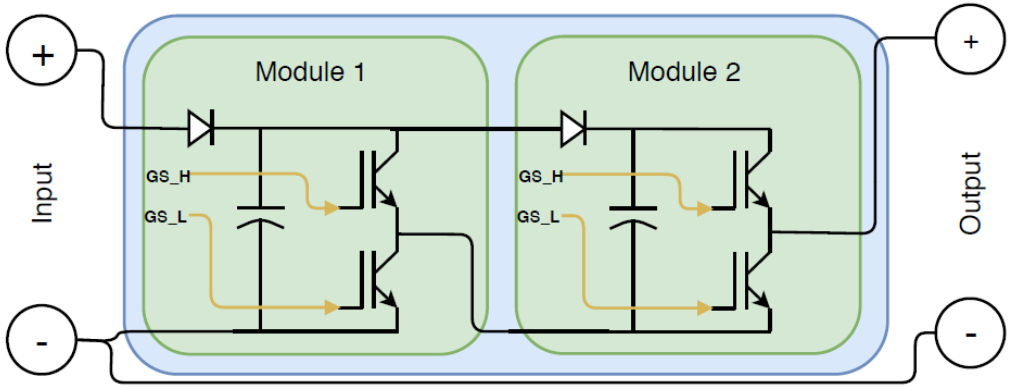

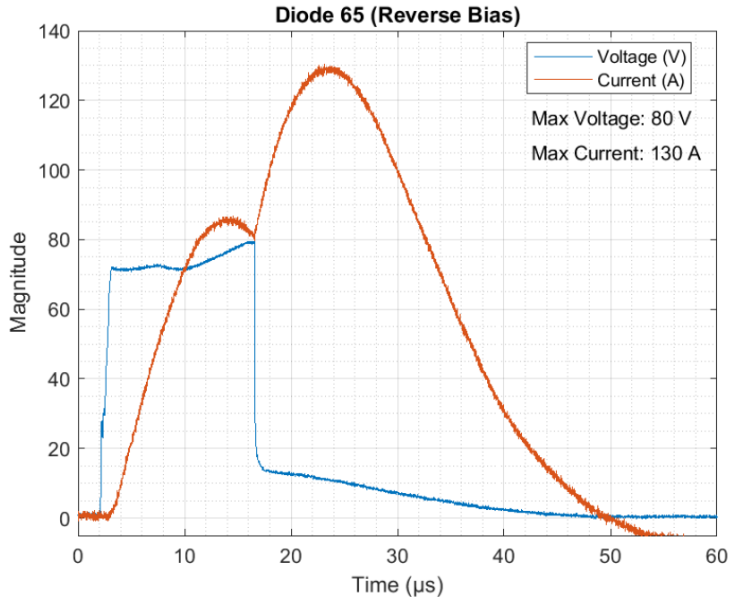

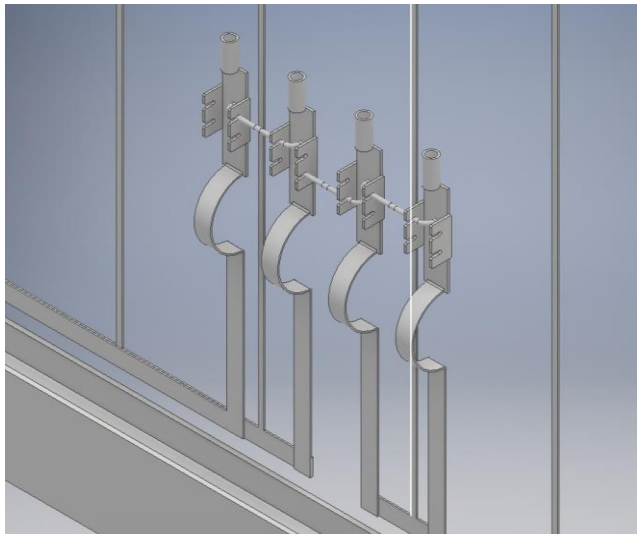

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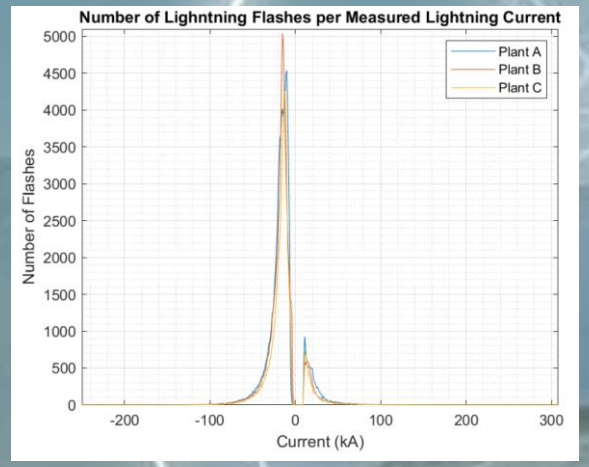

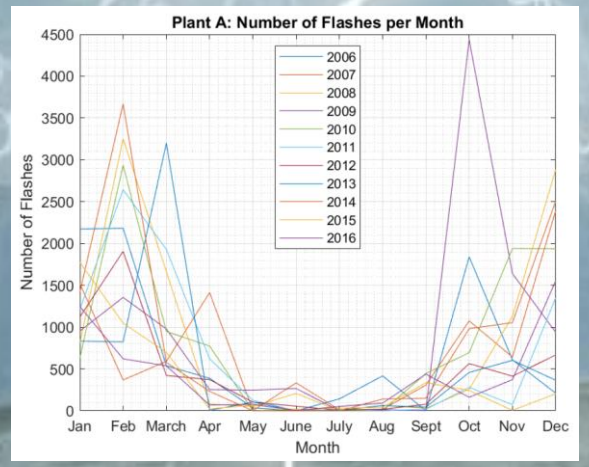

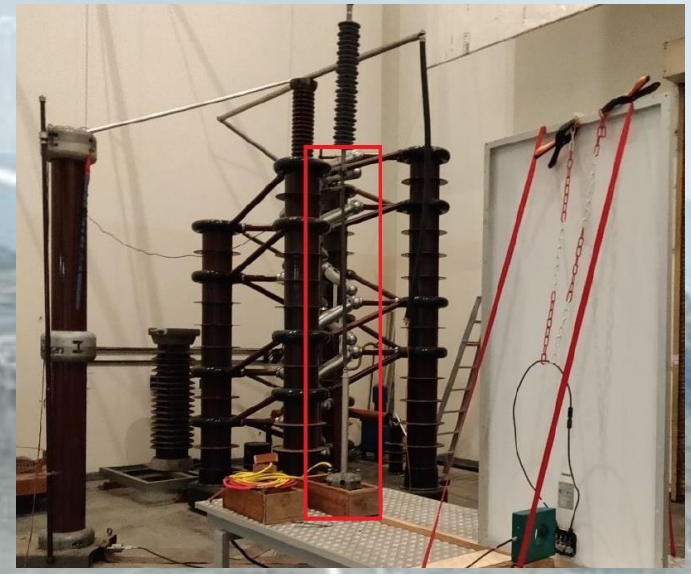

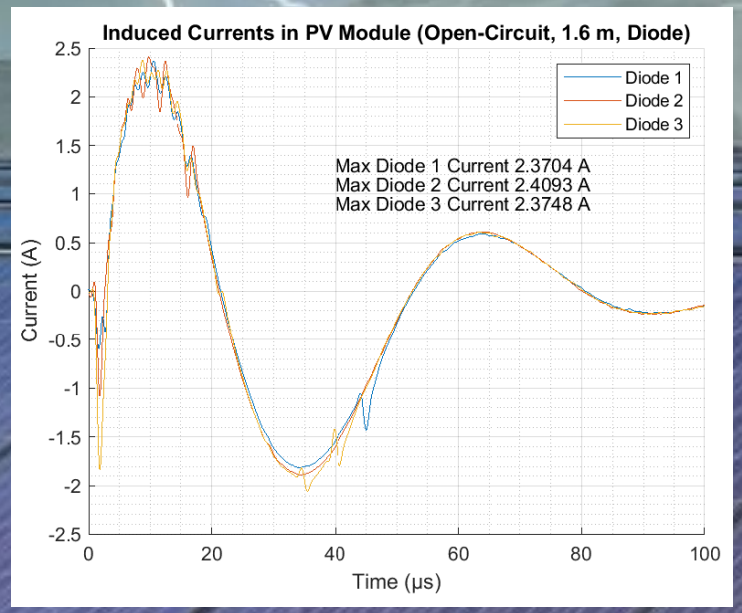

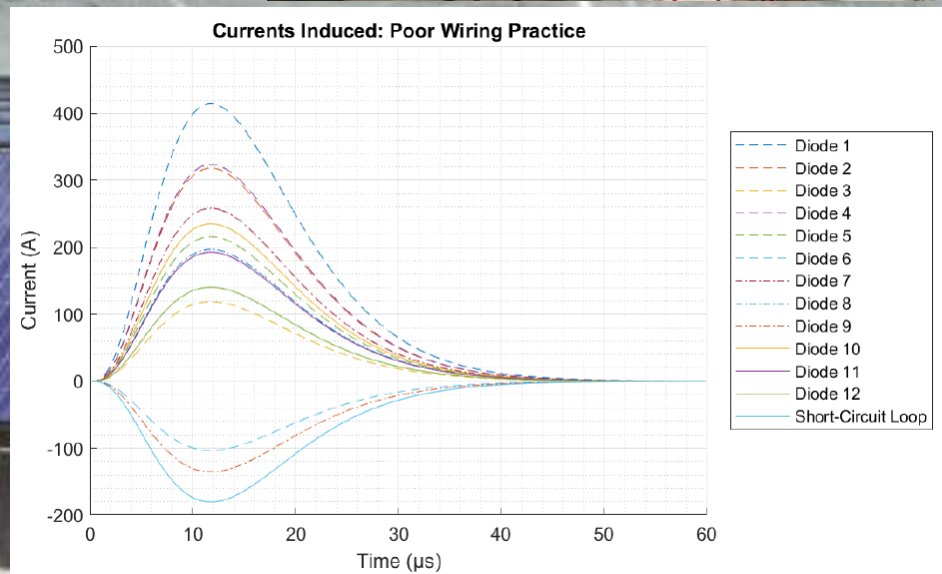

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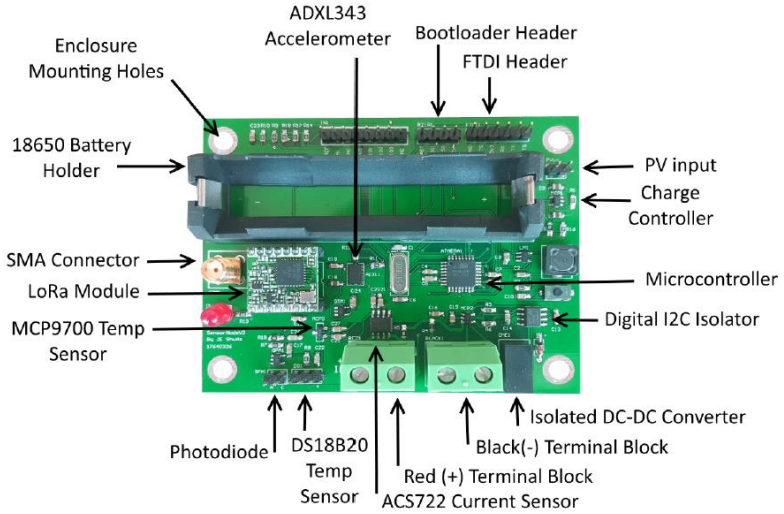

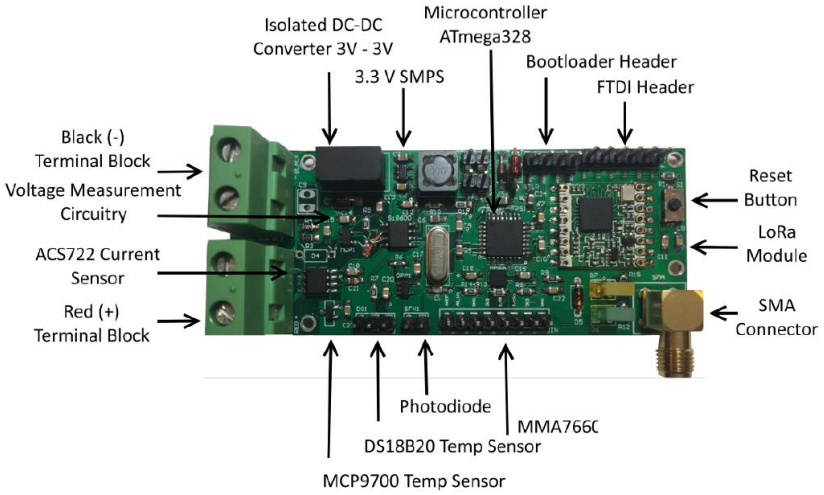

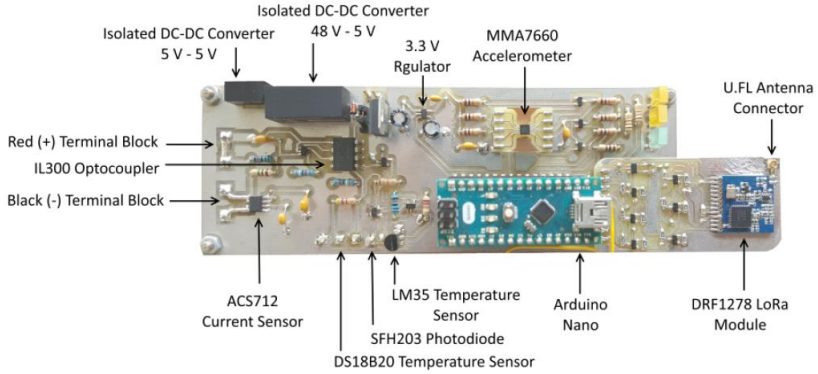

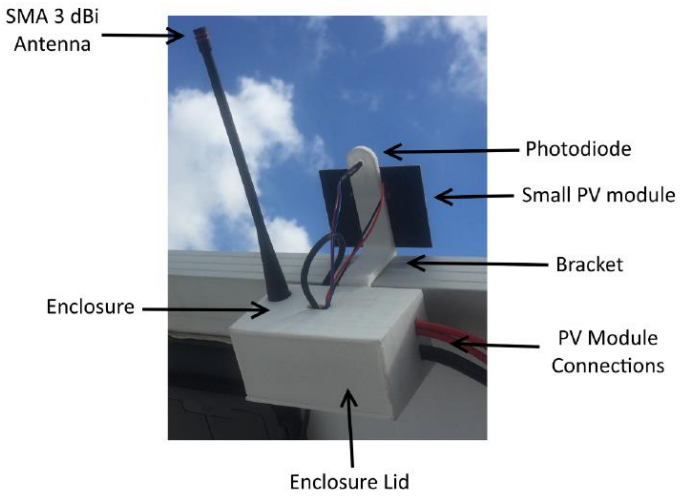

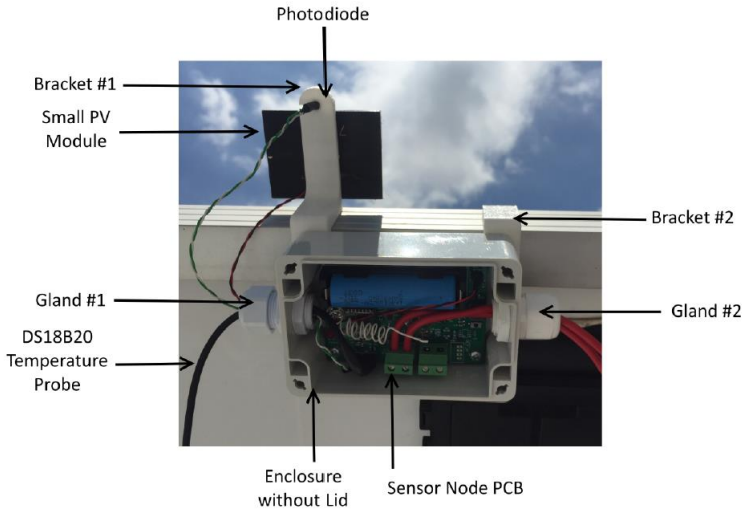

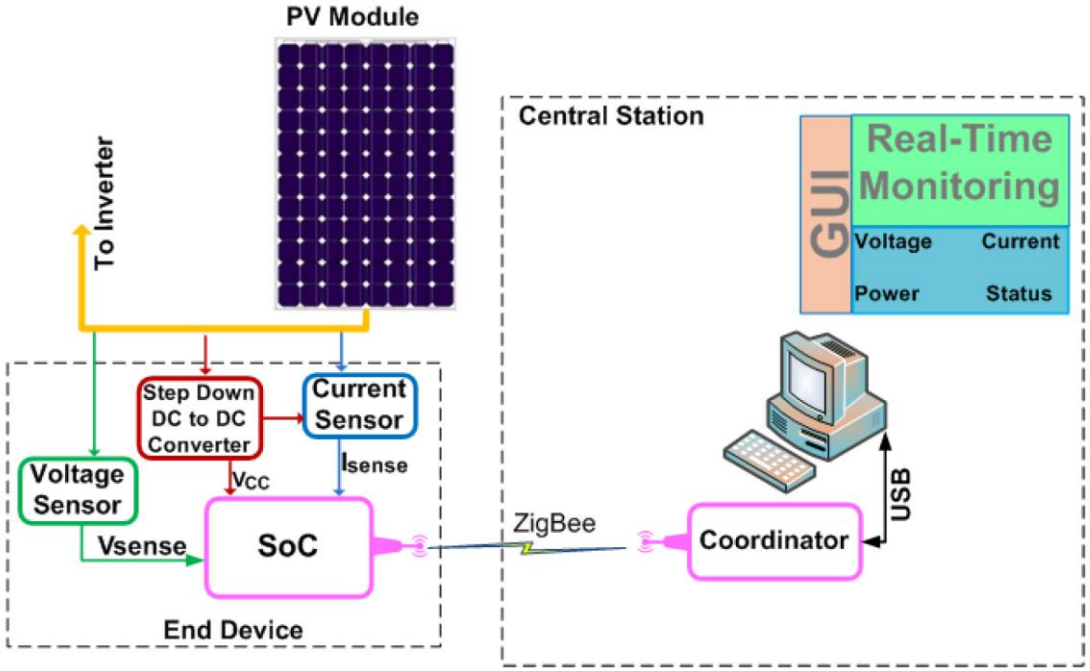

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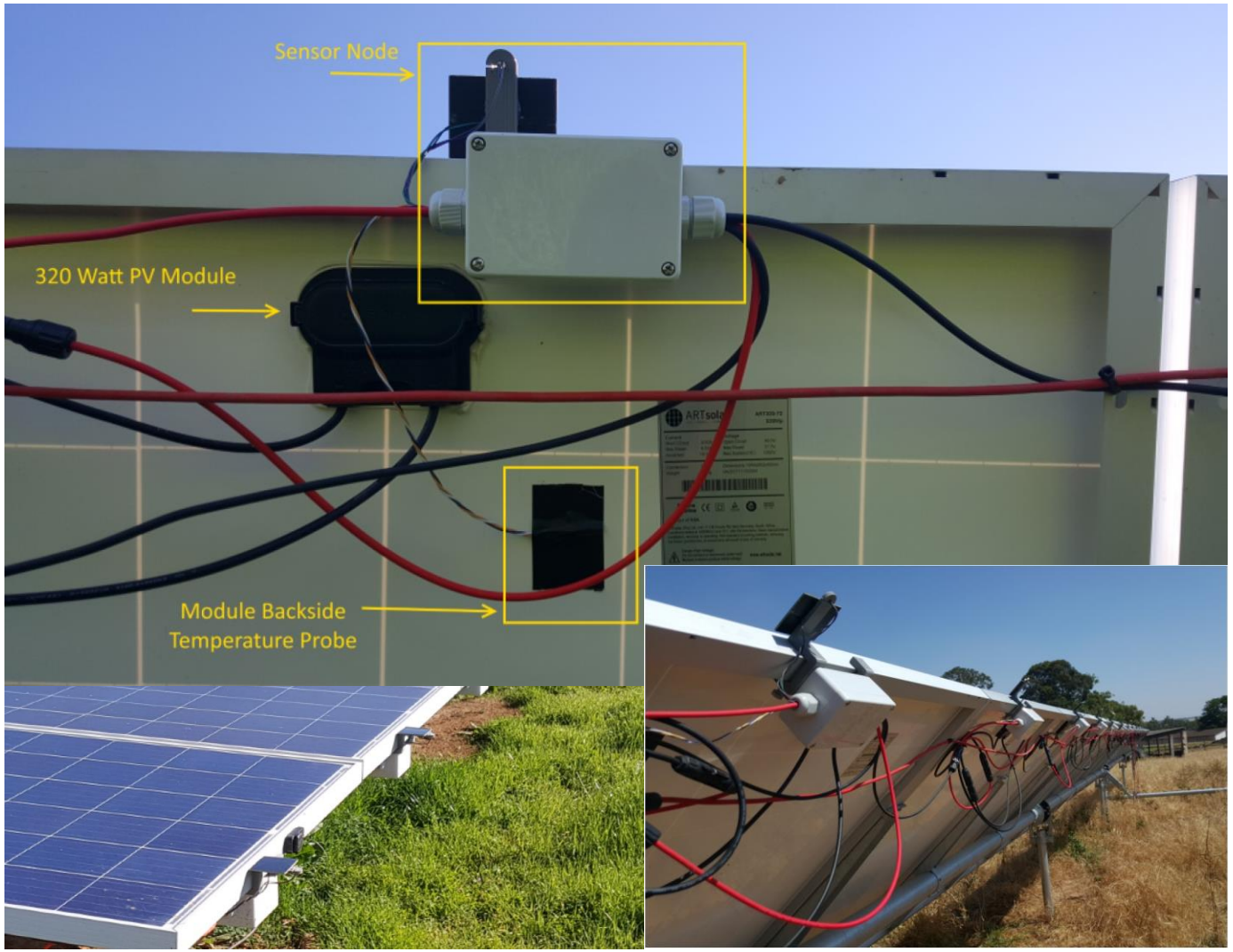

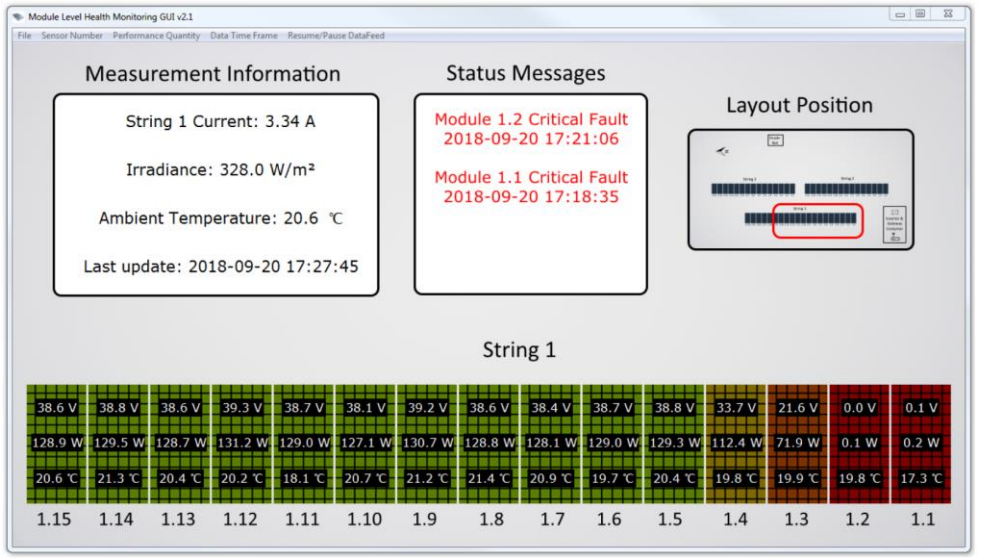

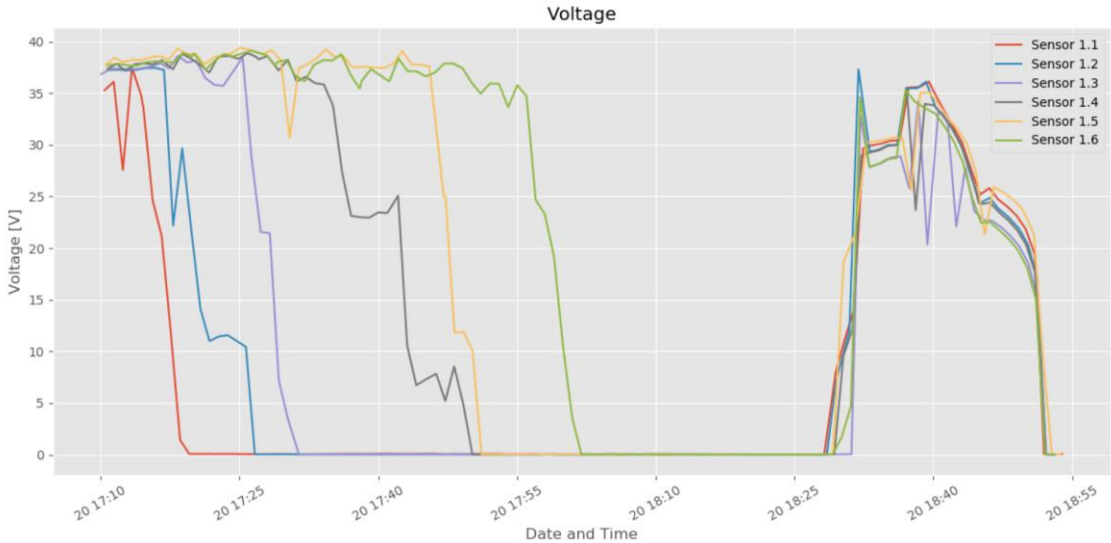

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Forecasting

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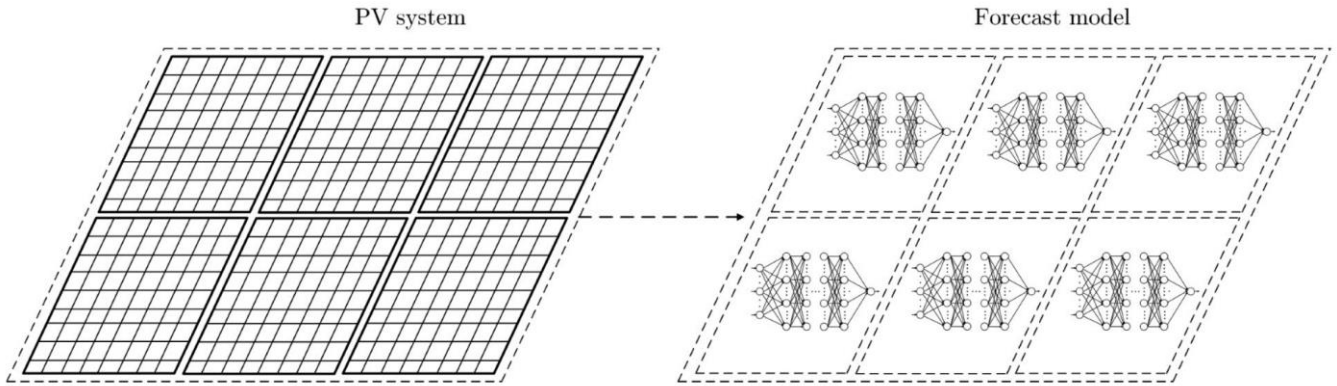
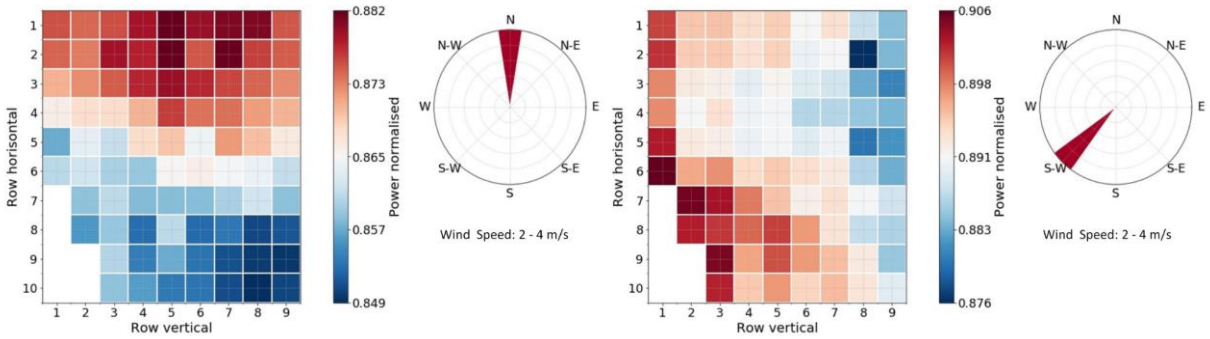
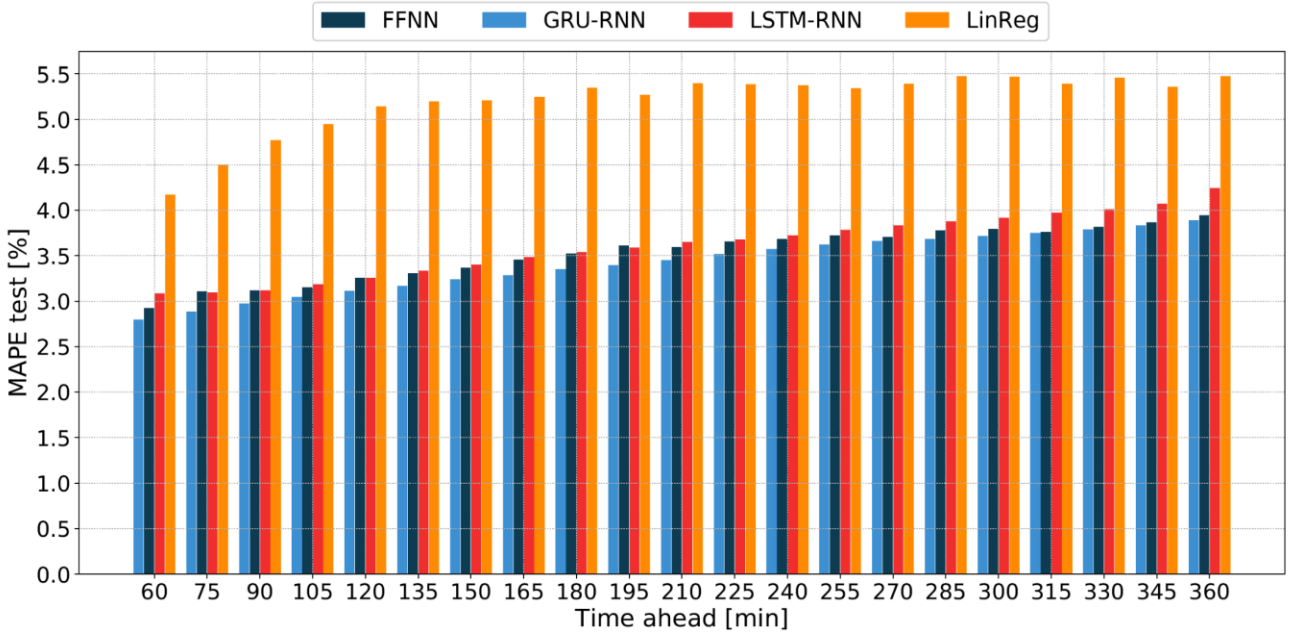


Figure 1.8: Suggested approach of aggregated low-level PV-system forecasts.





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Forecasting

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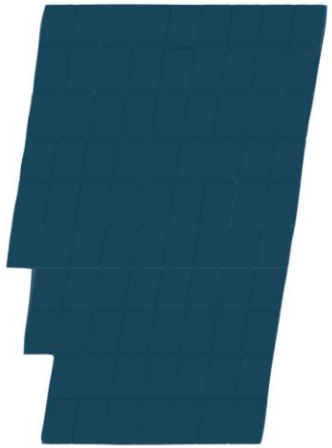
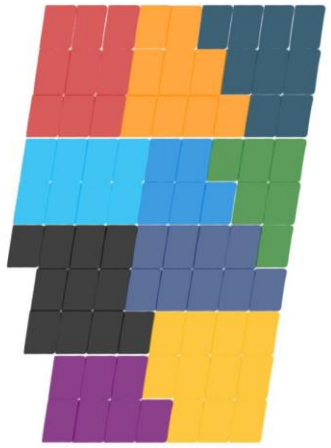
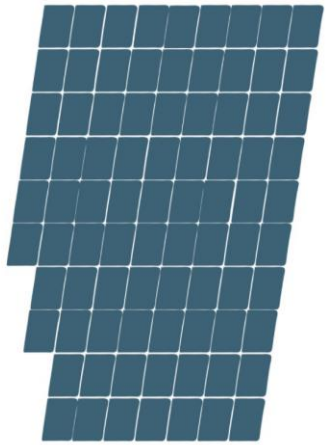


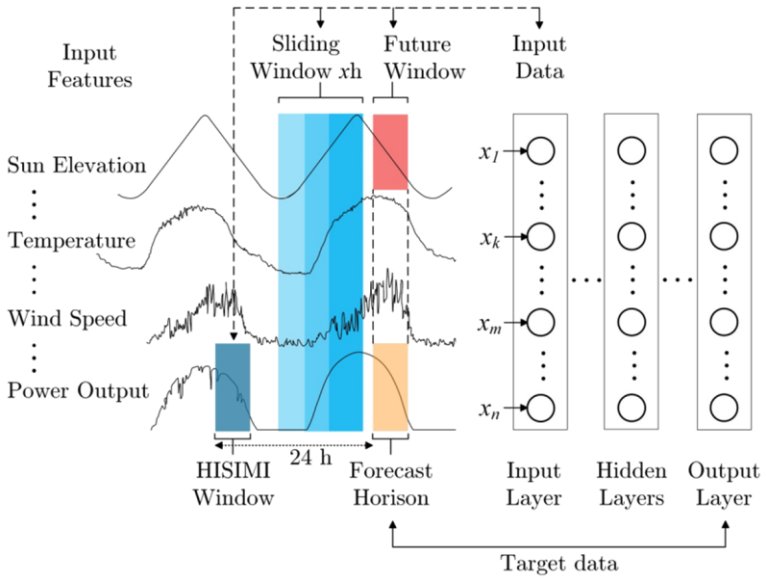
PV-system macro-level model

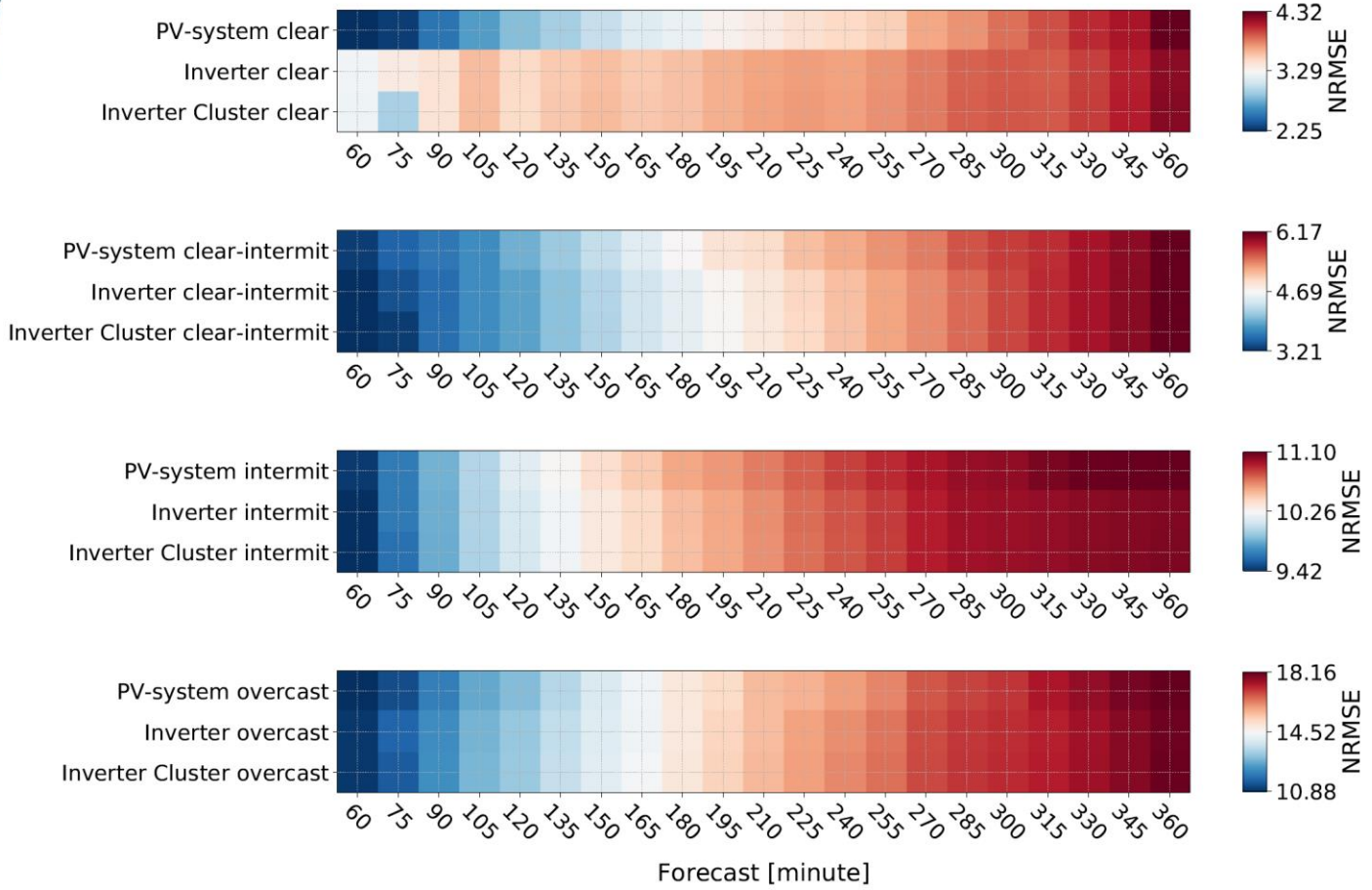


Aggregated Inverter-cluster model



Aggregated Inverter model





Hybrid system research

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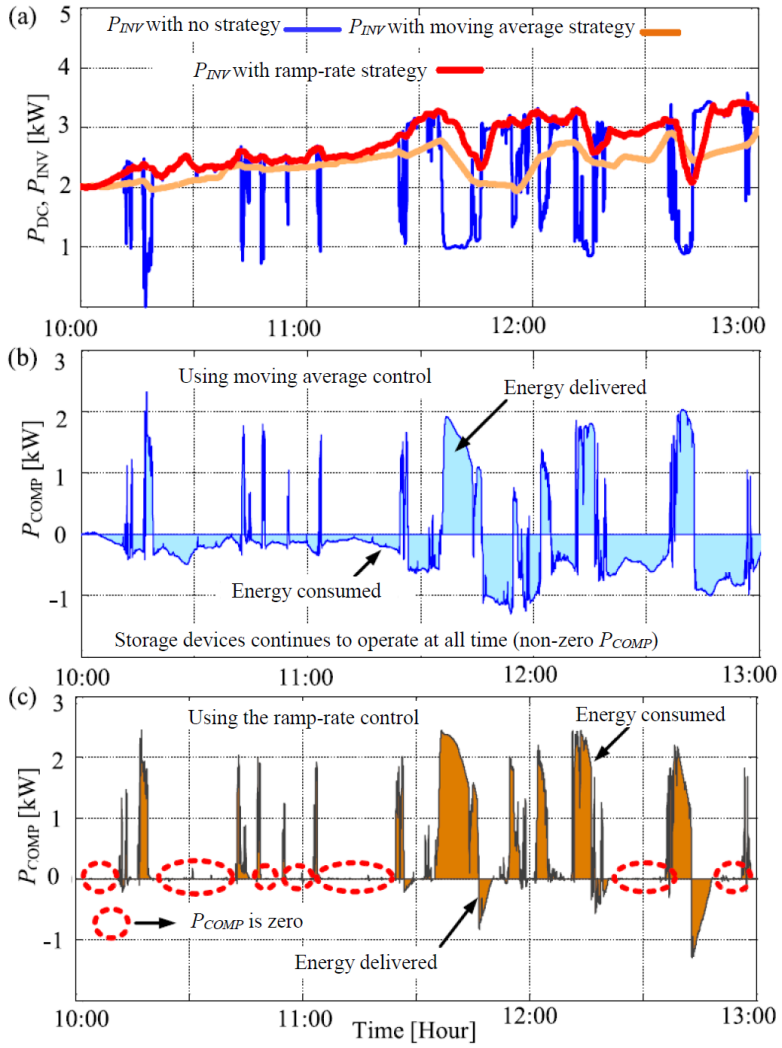

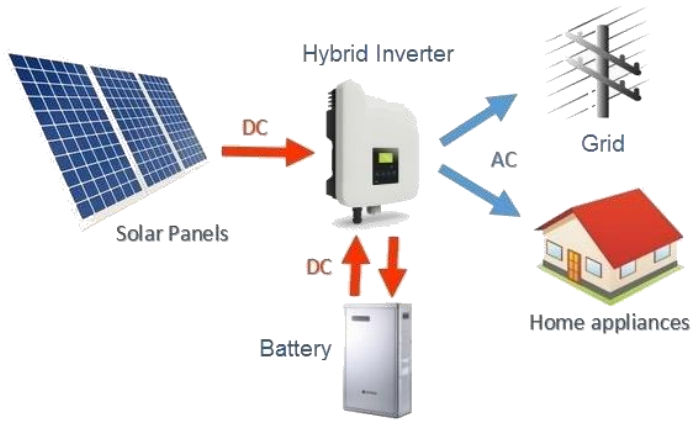

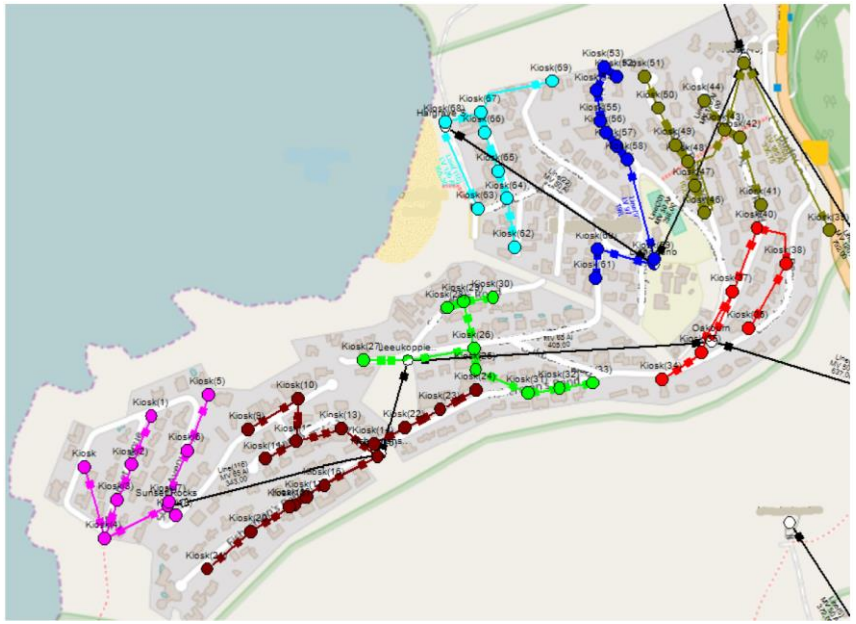

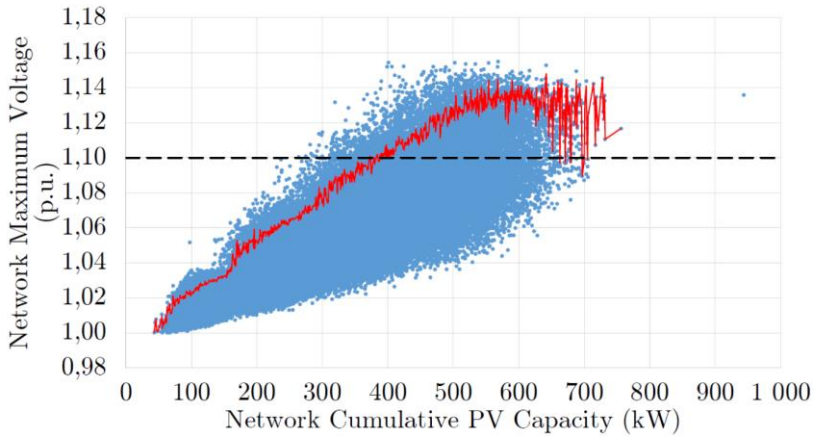

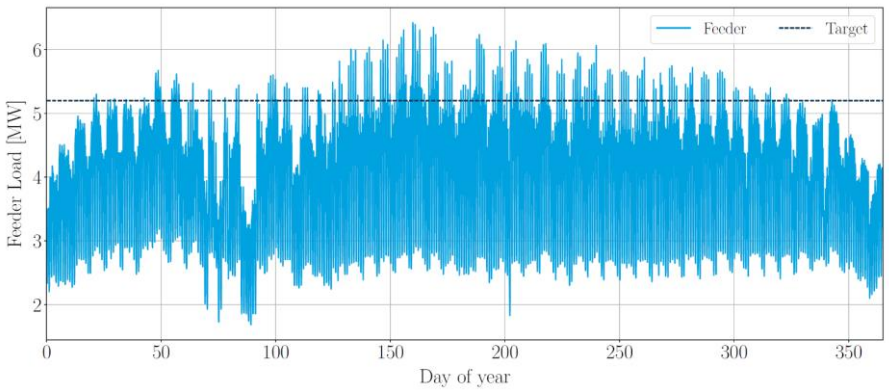

Hybrid system research

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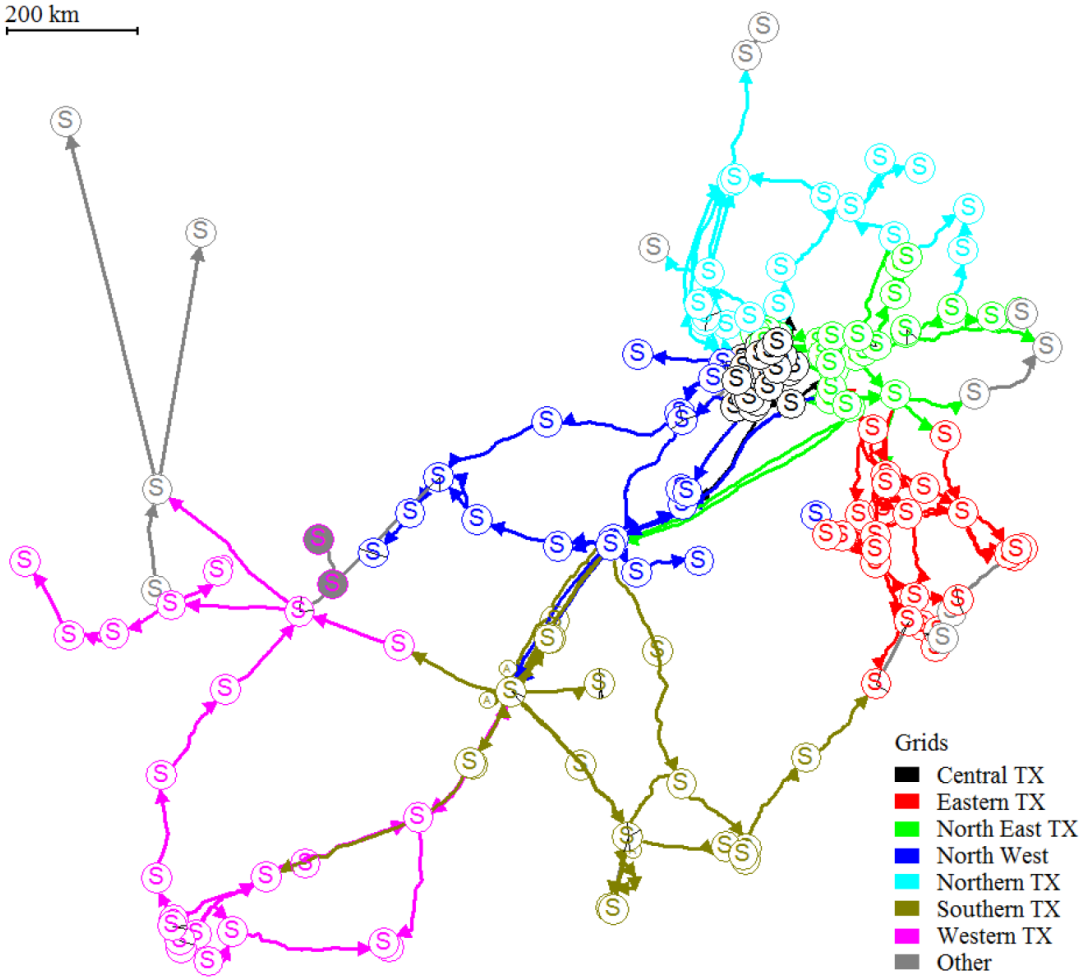
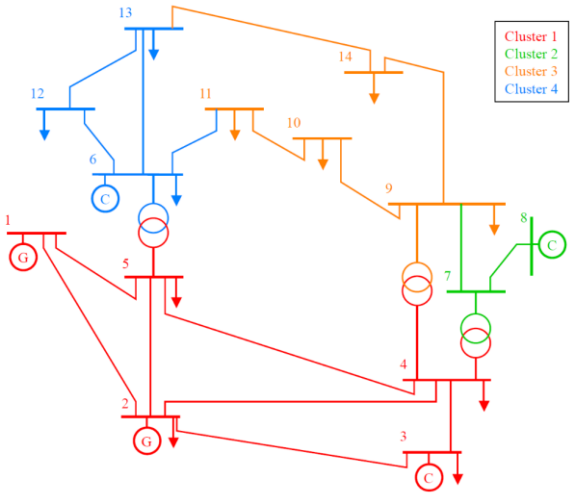
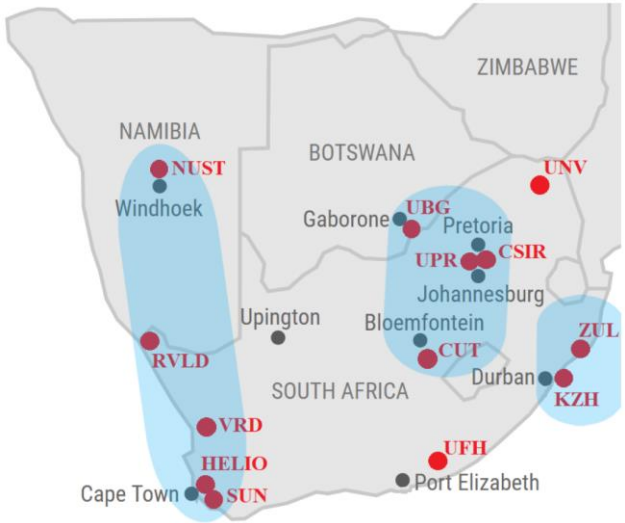


Cross-corr	RVLD	HELIO	VRD	CSIR	ZUL	UFH	CUT	SUN	NUST	UNV	UBG	UPR	KZH
RVLD	1	0.34	0.47	0.1	0.24	0.19	0.19	0.3	0.26	0.12	0.07	0.08	0.24
HELIO	0.34	1	0.36	0.09	0.16	0.27	0.22	0.6	0.16	0.05	0.05	-0.01	0.18
VRD	0.47	0.36	1	0.17	0.26	0.23	0.25	0.39	0.26	0.18	0.12	0.16	0.22
CSIR	0.1	0.09	0.17	1	0.12	0.14	0.26	0.13	0.23	0.23	0.28	0.49	0.11
ZUL	0.24	0.16	0.26	0.12	1	0.19	0.26	0.22	0.21	0.08	0.14	0.06	0.43
UFH	0.19	0.27	0.23	0.14	0.19	1	0.25	0.25	0.19	0.13	0.16	0.05	0.18
CUT	0.19	0.22	0.25	0.26	0.26	0.25	1	0.25	0.26	0.14	0.3	0.19	0.22
SUN	0.3	0.6	0.39	0.13	0.22	0.25	0.25	1	0.18	0.13	0.08	0.04	0.21
NUST	0.26	0.16	0.26	0.23	0.21	0.19	0.26	0.18	1	0.21	0.21	0.15	0.2
UNV	0.12	0.05	0.18	0.23	0.08	0.13	0.14	0.13	0.21	1	0.2	0.21	0.08
UBG	0.07	0.05	0.12	0.28	0.14	0.16	0.3	0.08	0.21	0.2	1	0.29	0.11
UPR	0.08	-0.01	0.16	0.49	0.06	0.05	0.19	0.04	0.15	0.21	0.29	1	0.03
KZH	0.24	0.18	0.22	0.11	0.43	0.18	0.22	0.21	0.2	0.08	0.11	0.03	1



(a) IEEE-14 bus clustering result ($K = 4$).



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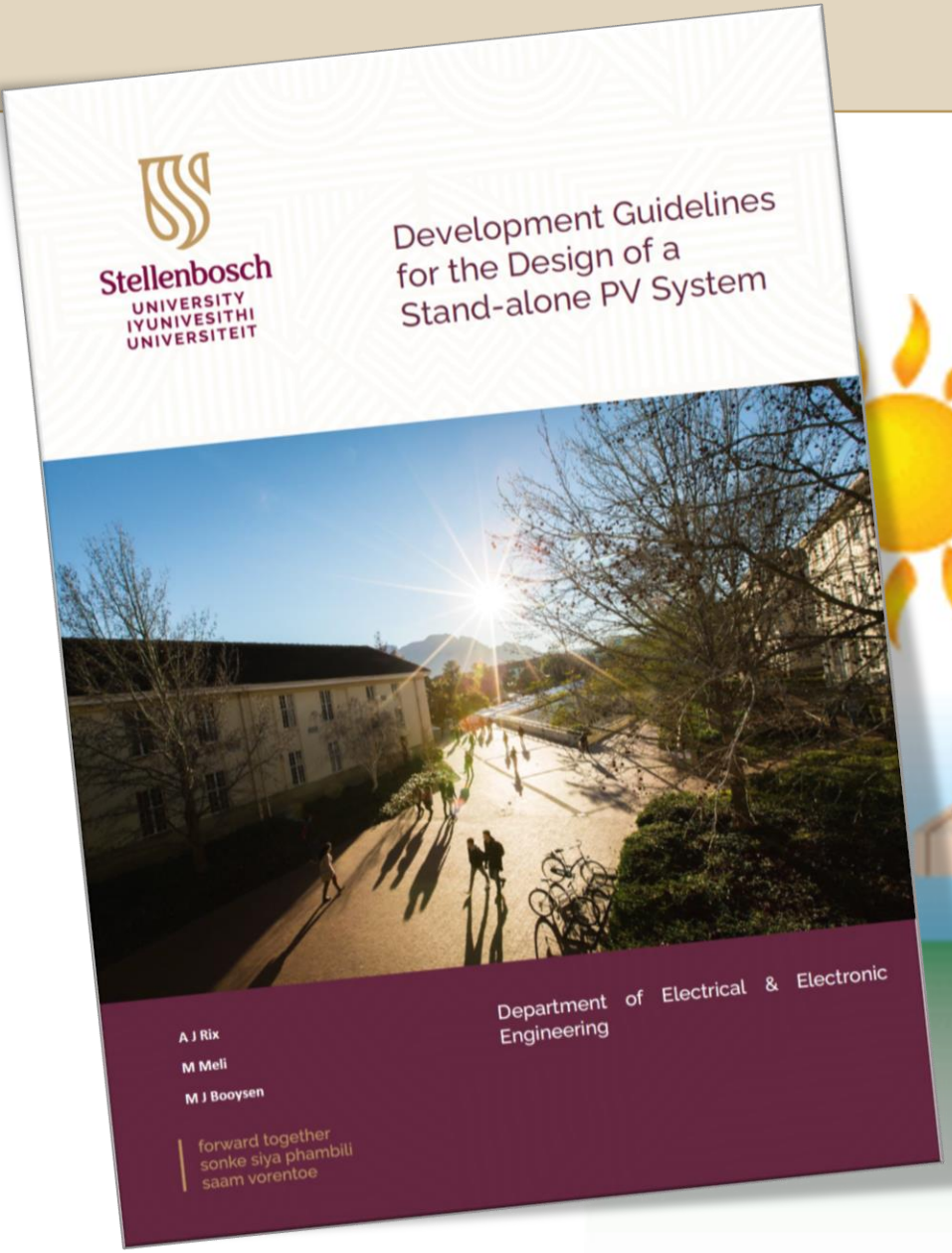

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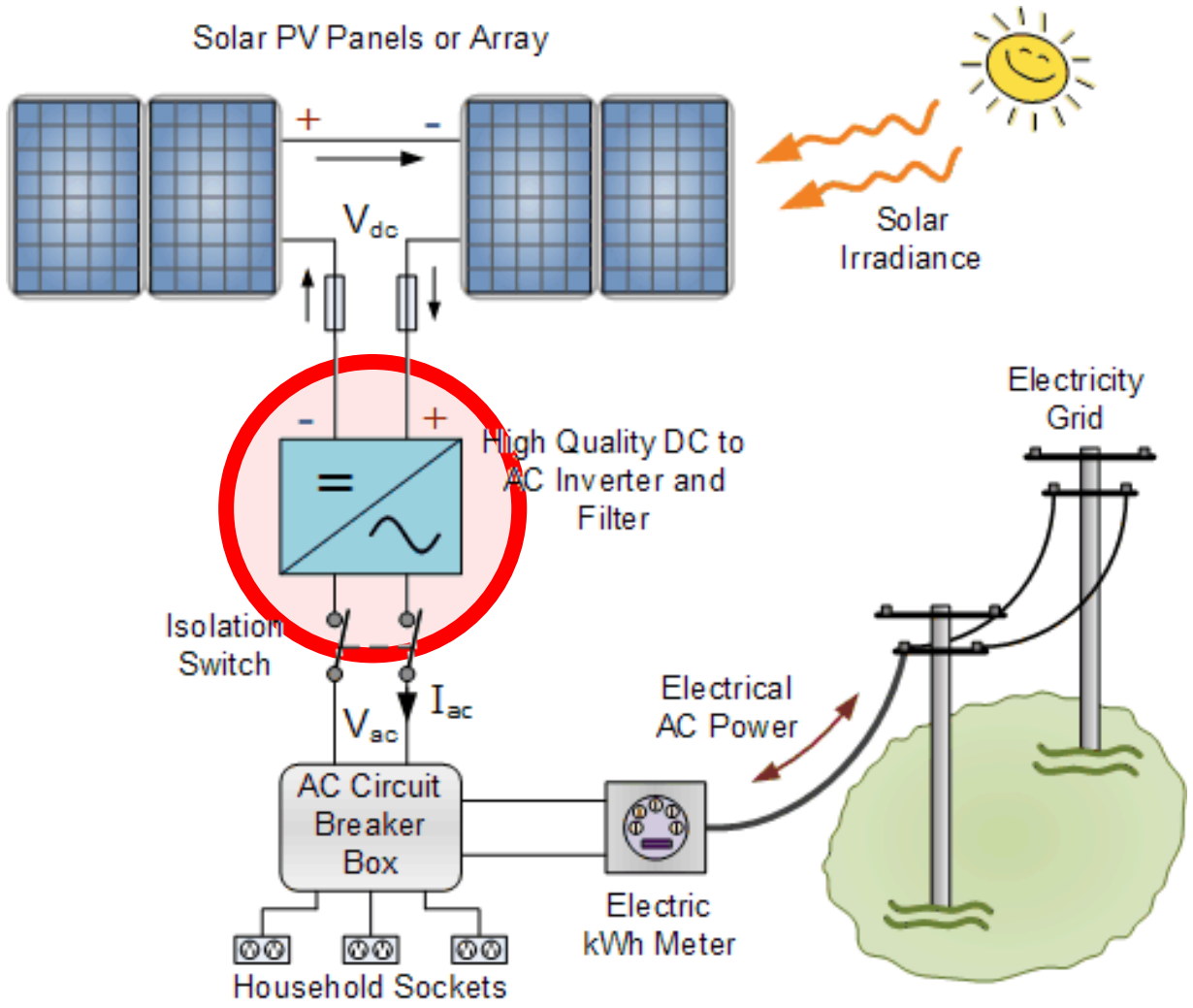
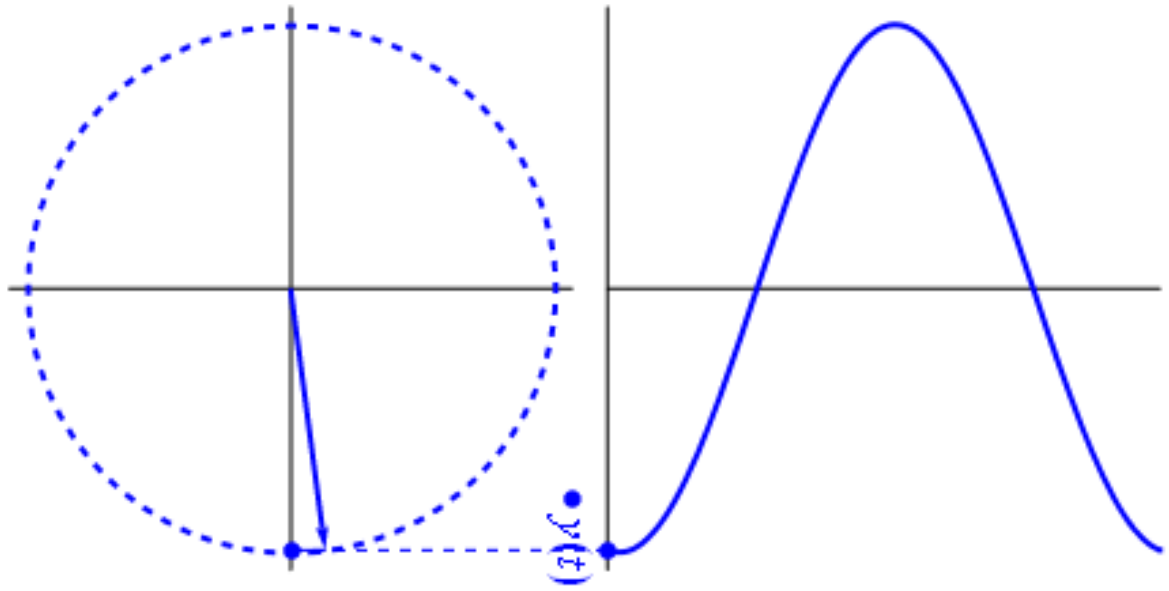


From DC (=) to AC (~)



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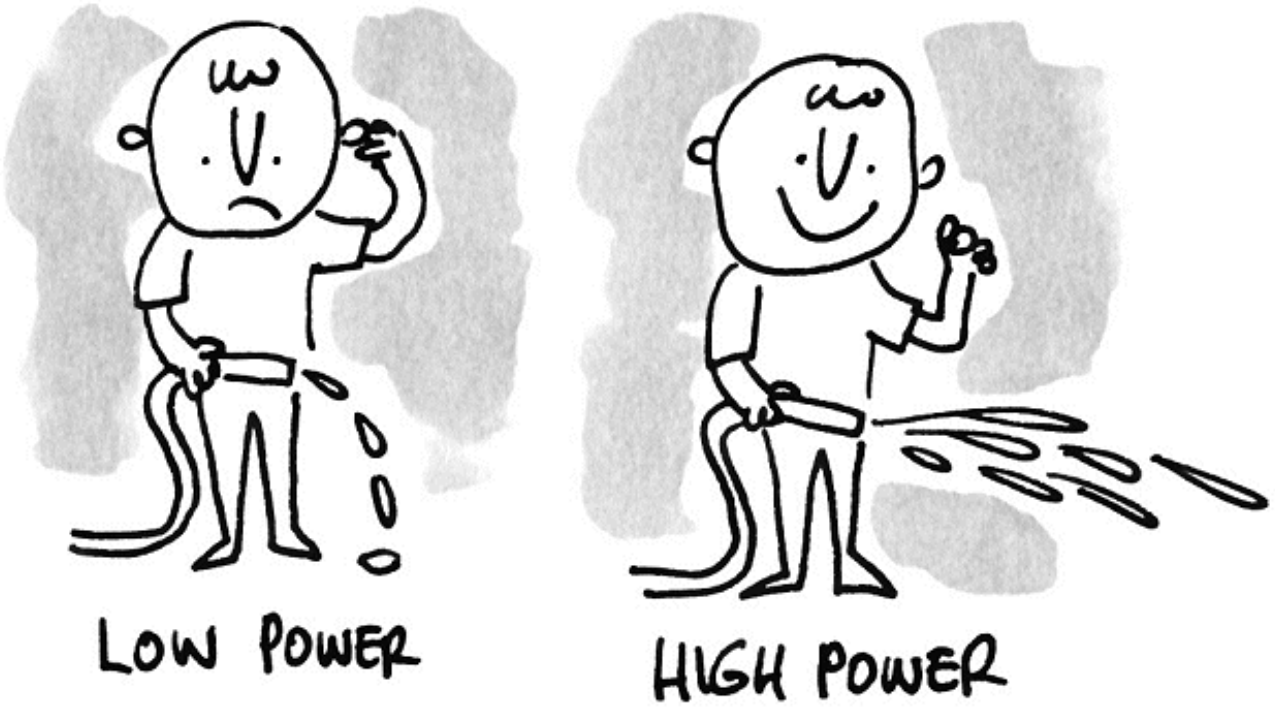
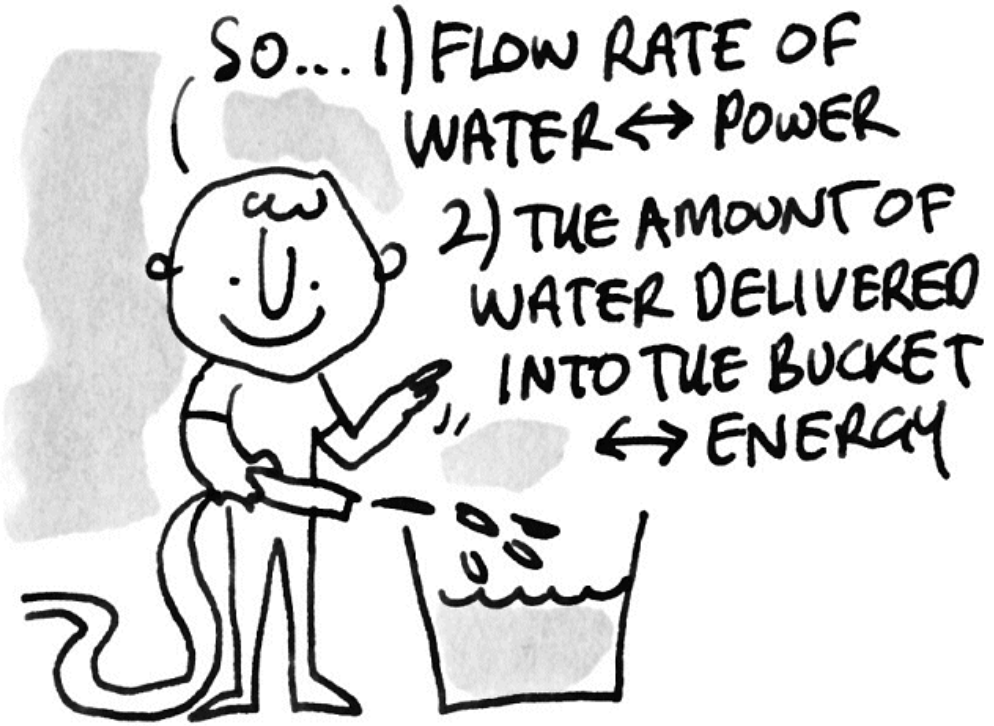
Power (Watt) vs. Energy (Watt-hour)





Inverter & PV modules

Batteries

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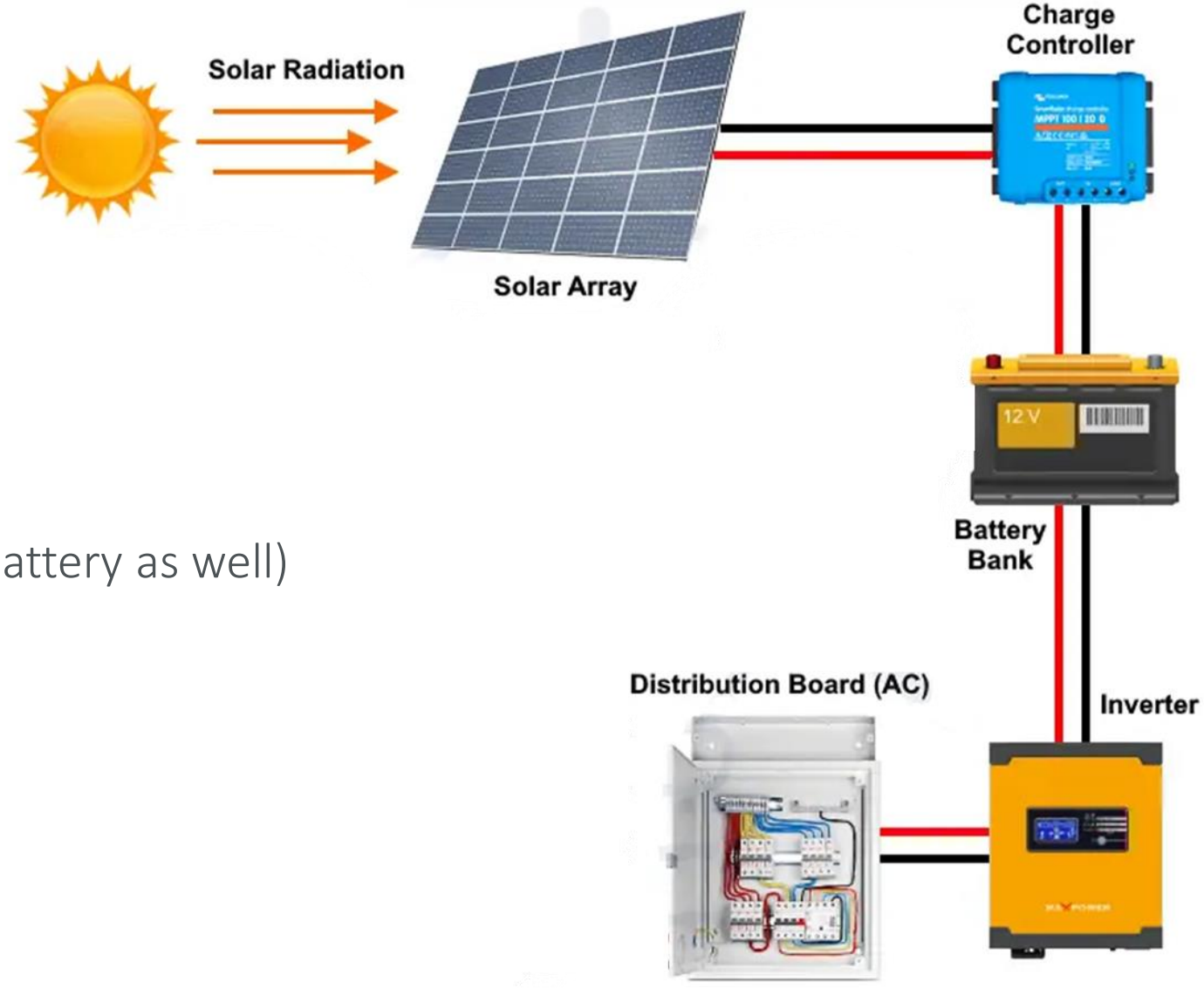
- Components required
  - PV modules
  - Battery
  - Inverter (Hybrid – can connect to battery as well)



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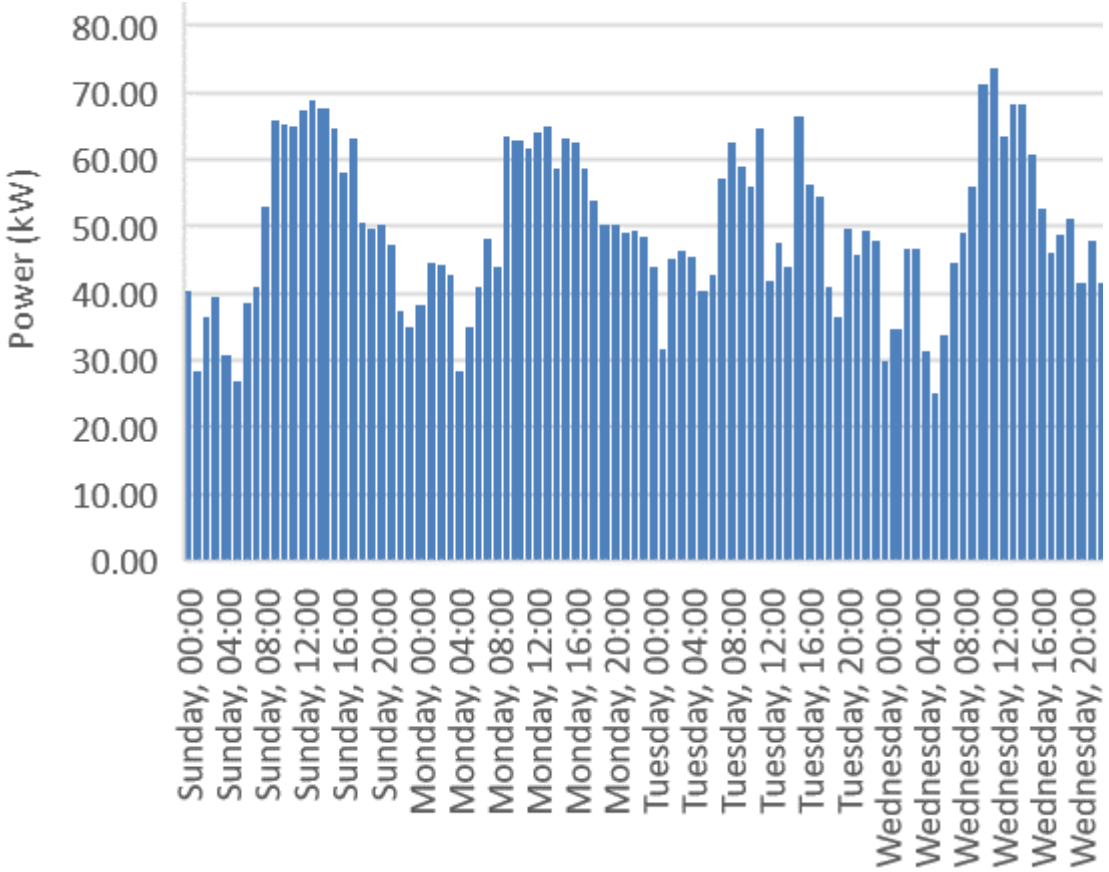
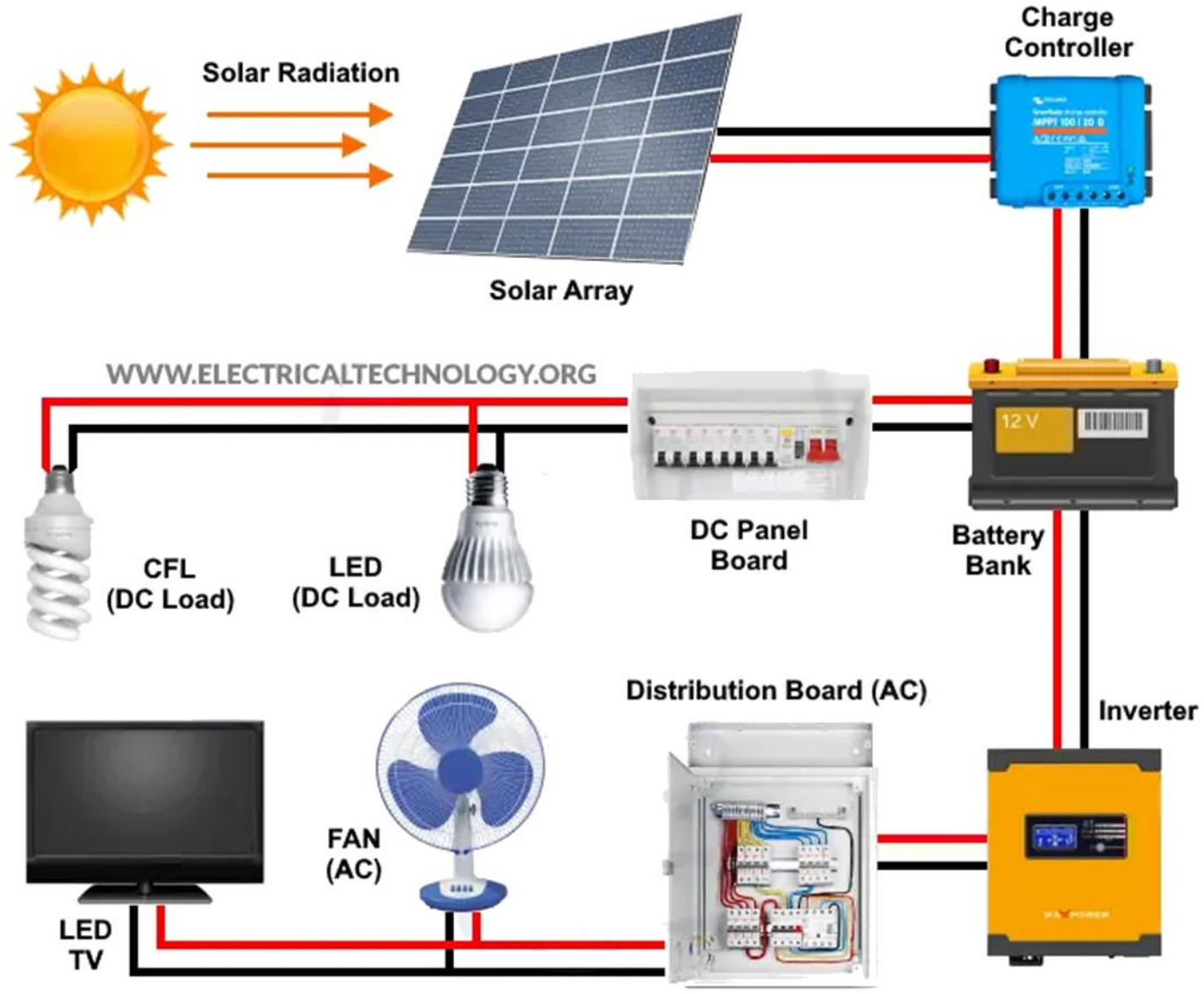
Estimate your load

Power (W) and Energy (Wh)





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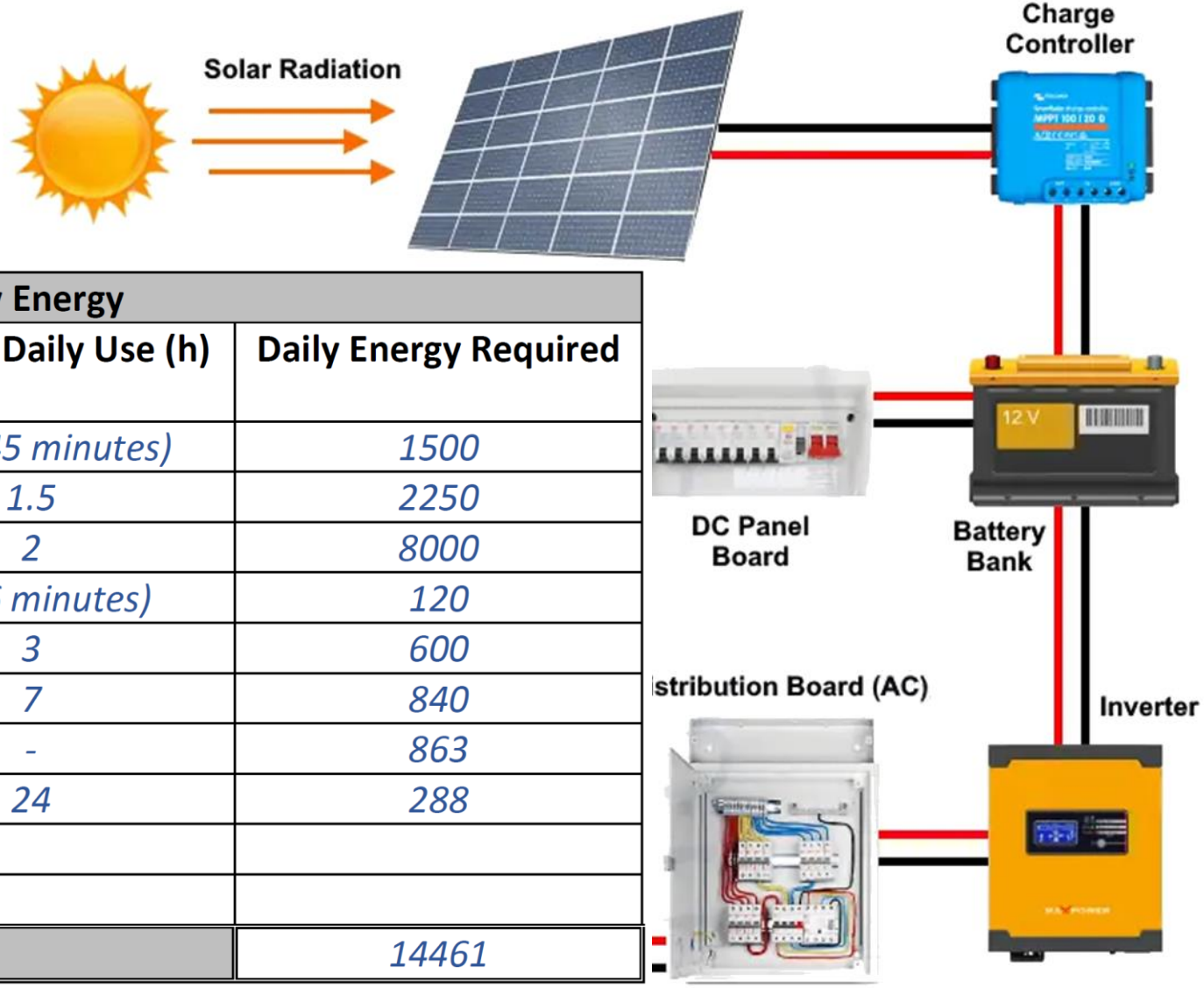
Estimate your load

Power (W) and Energy (Wh)



Estimation of Required Daily Energy			
Load/Appliance	**Rated Power (W)**	**Hours of Daily Use (h)**	**Daily Energy Required**
Washing Machine	*2000*	*0.75 (45 minutes)*	*1500*
Dishwasher	*1500*	*1.5*	*2250*
Oven	*4000*	*2*	*8000*
Kettle	*1200*	*0.1 (6 minutes)*	*120*
Television	*200*	*3*	*600*
Lights	*120*	*7*	*840*
Fridge-Freezer	*700*	*-*	*863*
Wi-Fi Router	*12*	*24*	*288*
Total	*9732*		*14461*

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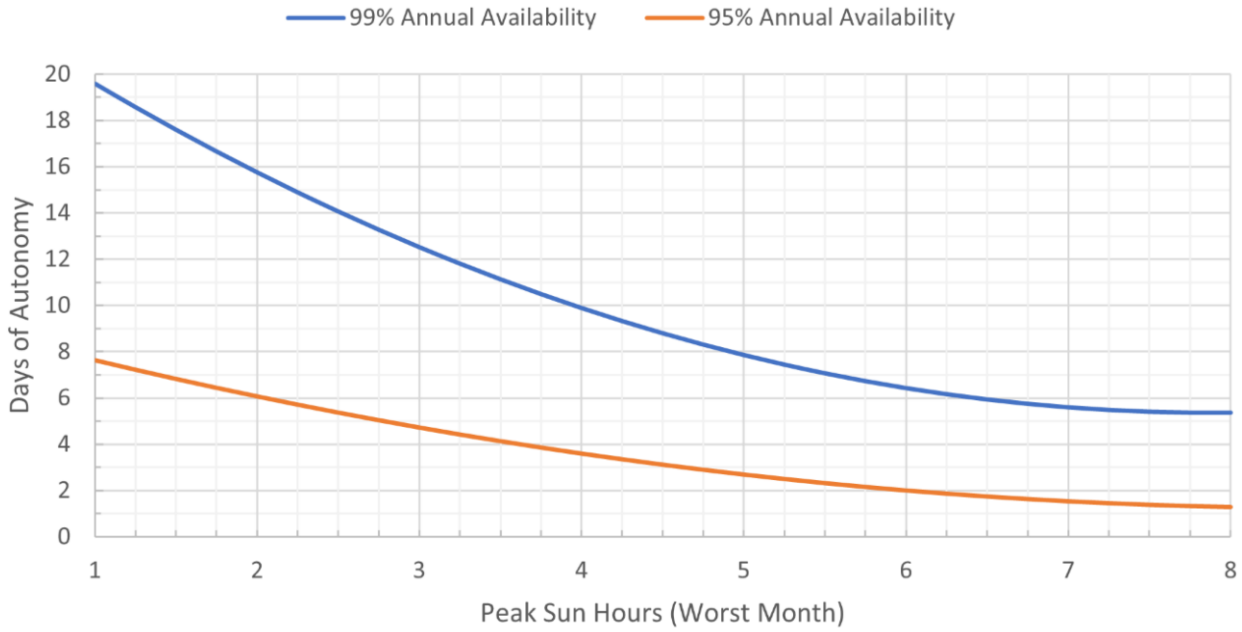
Determine the size of the battery

- Efficiencies
- Maximum depth of discharge
- Hours/Days of storage required



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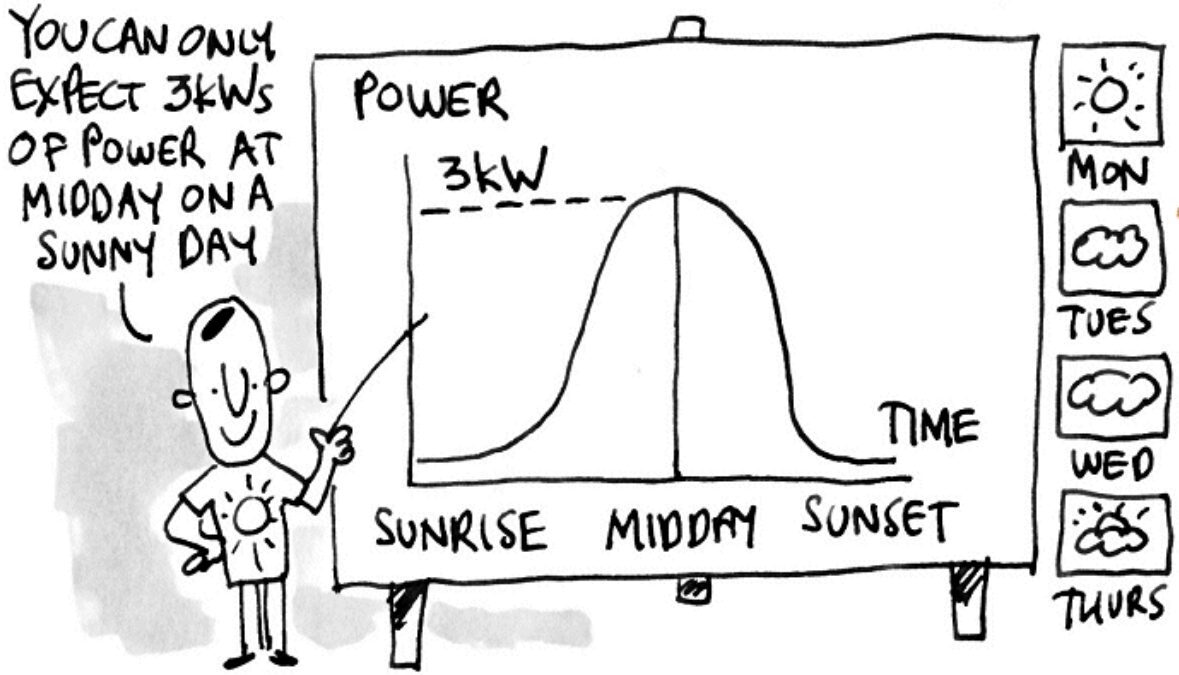
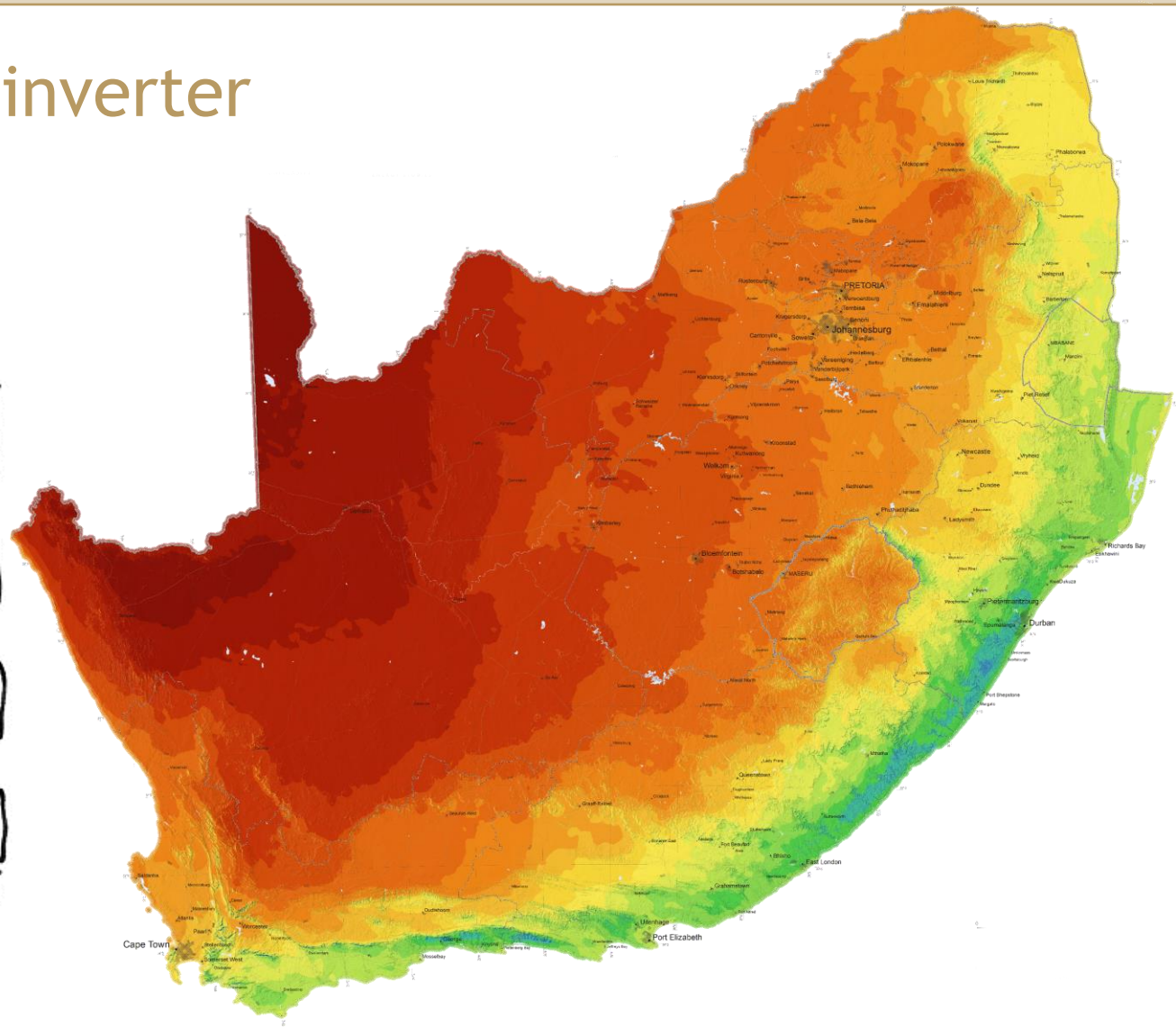
Determine the size of the PV and inverter

- Efficiencies
- Peak loads -> power
- How much sun –> energy



https://re.jrc.ec.europa.eu/pvg_tools/en/



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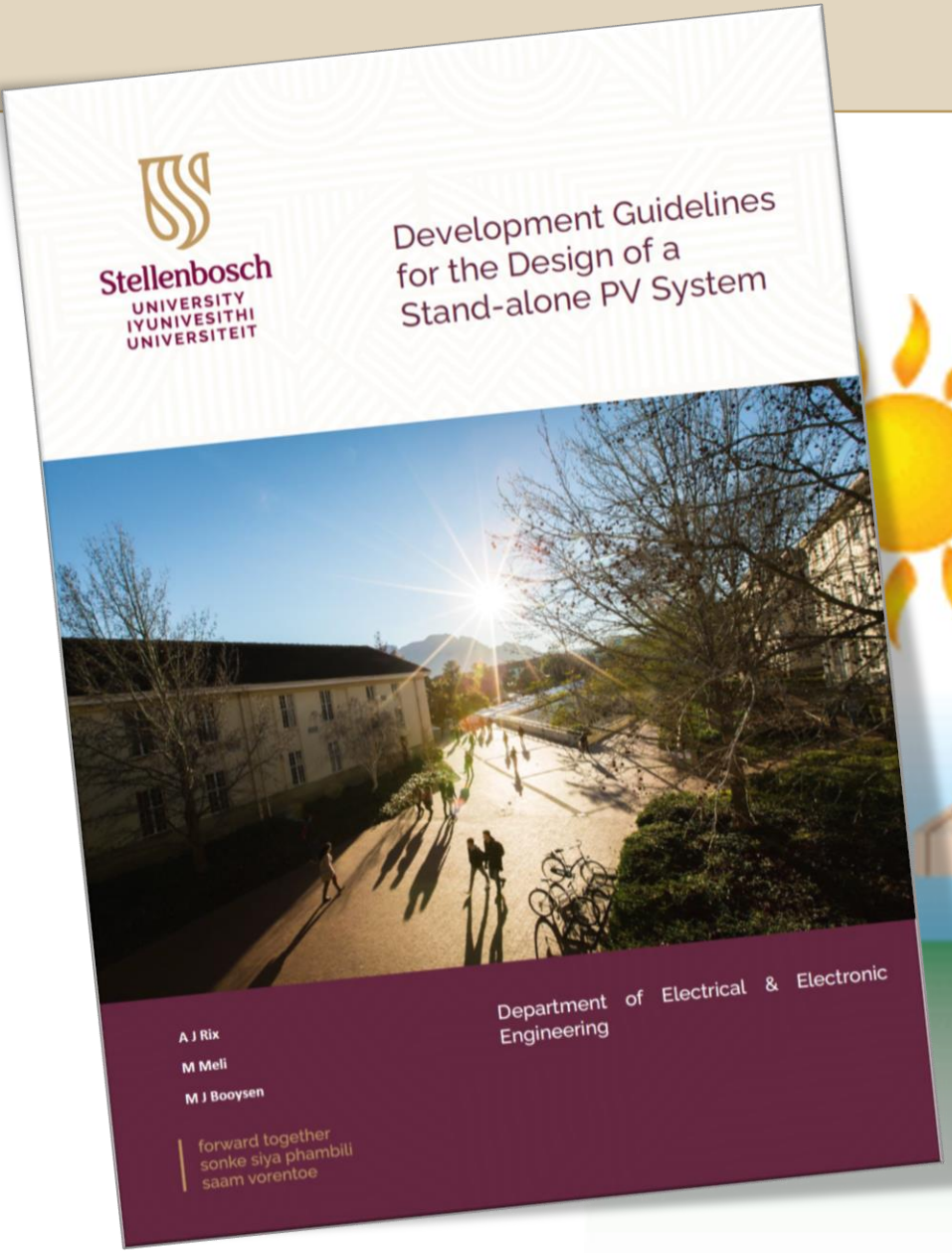

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Thank you

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https://www.researchgate.net/profile/Arnold_Rix