# Supply- and Demand-side Assessment of a Domestic Photovoltaic Off-Grid System

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# Synopsis

- Background
- Site & PV system description
  - *Geographical location*
  - *PV power generator structure*
- Research method and instrumentation
  - *Electrical and meteorological measurements*
- Results and discussions
- Conclusions (way-forward)

# Background

Energy supply

- Aging coal-fired power plants
- Overstrained grid

Energy crisis

Nationwide load shedding – 2019

Coal-fired power plants – 90%

Nuclear power plants – 6%

Rural community

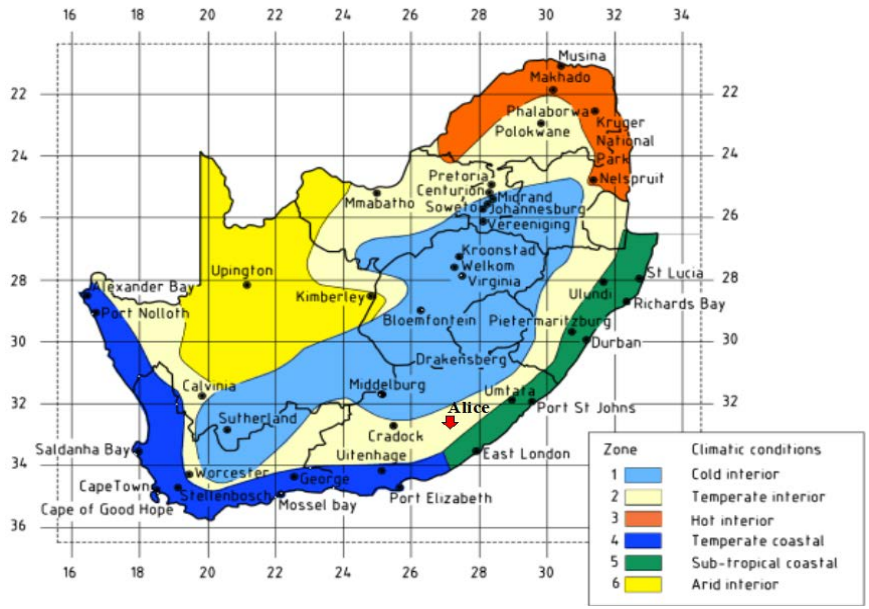
Microgrid for rural settlement

Aim

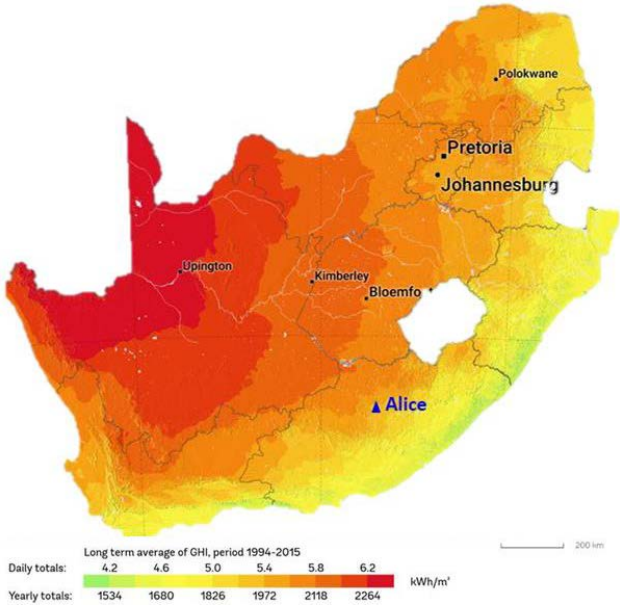
This study aims to explore the performance of a domestic photovoltaic off-grid system.

# Site & PV system description

## *Geographical location*




Climatic map of South Africa (*SANS 204: 2011*)




Solar map of South Africa (*SOLARGIS: 2017*)

- Latitude 32.8° S and longitude 26.8° E
- Altitude of 540 m in Eastern Cape

- Total daily global horizontal irradiation is between 5.4 to 5.8 kWh/m²
- Annual irradiation of 1972 to 2118 kWh/m².
- Resultant daily and annual cumulative PV power generation was at 5.0 and 1826 kWh/kWp

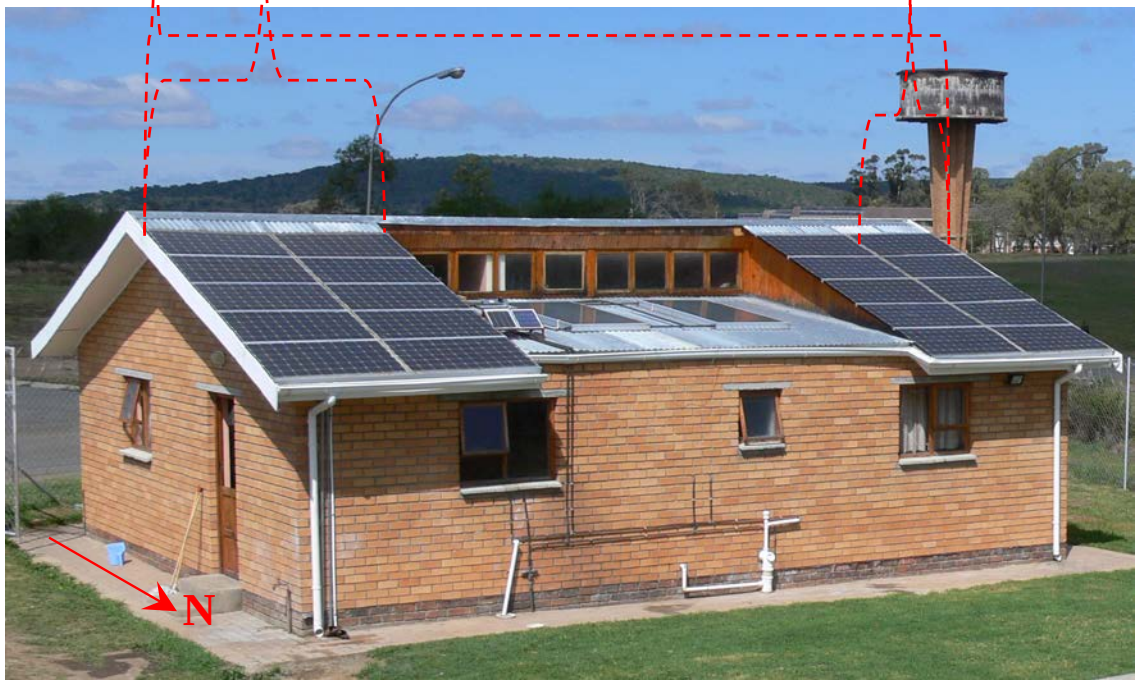
# Site & PV system description

## *PV power generator structure*

20 modules – 2 connected in series - 10 PV parallel ~ 3.8 kWp

2 modules connected in series - 5 PV parallel

190 W



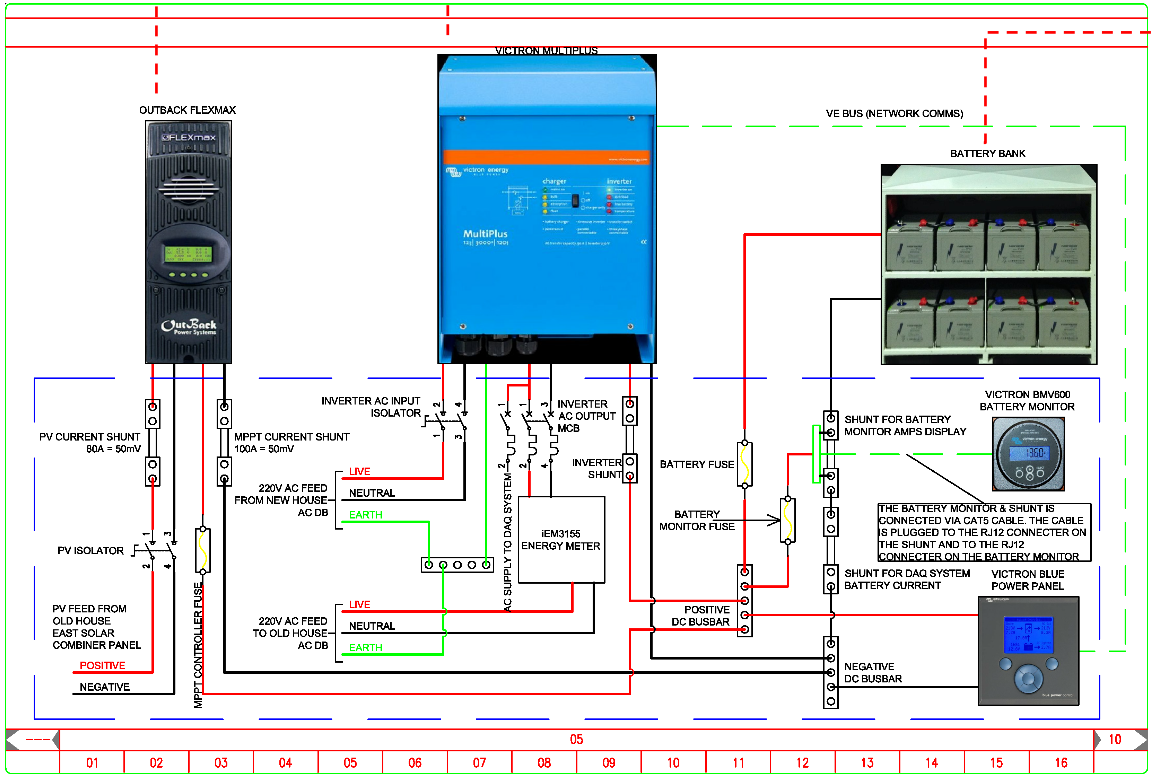

Rooftop PV system

# Site & PV system description

## *PV power generator structure*

FLEX max 80 MPPT, 12 – 60 VDC (Batt. Volt), 80 amps (Adjus. output) & 97.5% Eff.

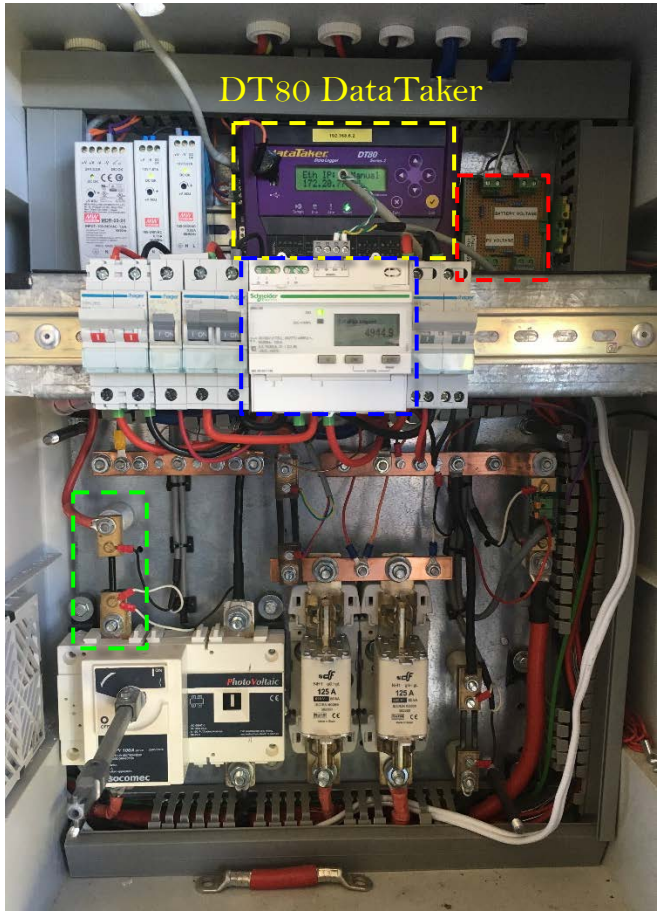
MultiPlus Inverter, 38 – 66 VDC (input), 230 VAC ± 2% (output), 5kVA, 4 – 4.5 kW (output) & 95% Eff.



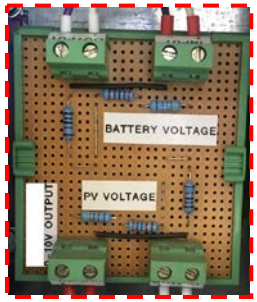

- Eight 6 V M-Solar 3MIL 25S batteries.
- At constant temperature of 25°C
- Delivers 900 Ah with cell voltage above 1.85 V over 100 hrs discharge period

# Research method and Instrumentation

## *Electrical & meteorological measurements*

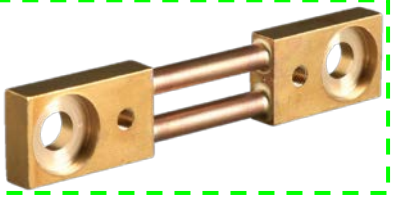



Electrical measurements




Voltage scaling device


Schneider IEM 3155 energy meter



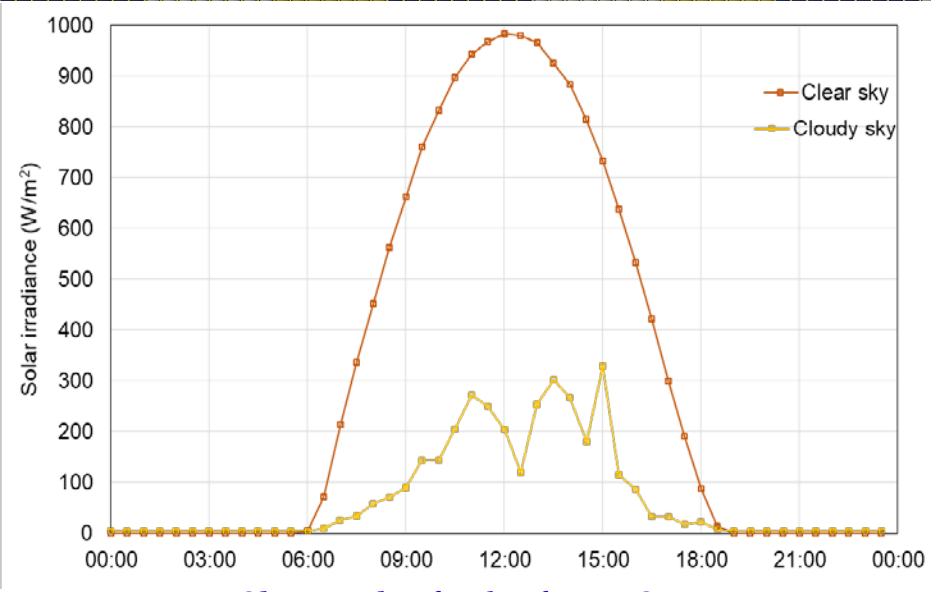
80 A shunt resistors

Measured Parameters

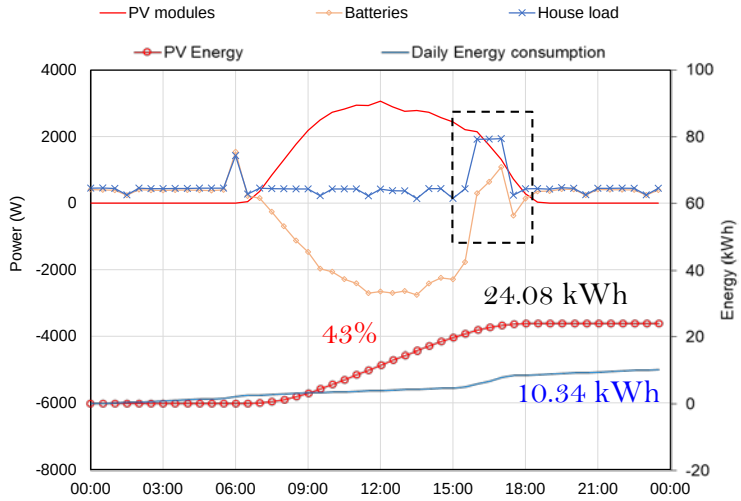
- PV voltage and current
- MPPT current
- Battery current and voltage
- Inverter AC current, voltage, power & energy.


Meteorological measurements

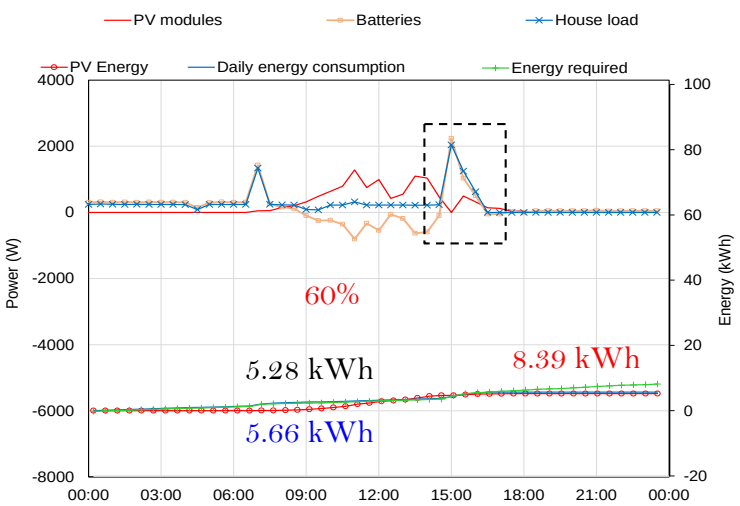
# Results and discussions




Clear & cloudy sky days - GHI




Clear sky day PV supply and demand




Cloudy sky day PV supply and demand

Clear sky day

- Average irradiance 583.72 W/m²
- Daily total irradiation 7.59 kWh/m²

Cloudy sky day

- Average irradiance 114.45 W/m²
- Daily total irradiation 3.09 kWh/m²

# Conclusions/ (way-forward)

- A domestic 3.8 kWp PV system performance with respect solar radiation in Alice under clear and cloudy sky conditions were presented in the study.
- The setup rooftop PV system continuously powered a single-family house without auxiliary (main) power supply on a typical clear sky day.
- On a cloudy sky day, auxiliary power supply will be required for cooking to ensure an uninterruptable power supply.
- An extensive load profiling of houses in the rural settlement is recommended for efficient and effective sizing of the PV system.

# Thank you for your attention !

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