Fault detection and isolation for renewable sources

2nd Incite Workshop, UPC, Barcelona

Nikolaos Sapountzoglou

PhD Student, ESR 4.2

UNIVERSITÉ Grenoble Alpes

G2E Lab Grenoble Génie Electrique Grenoble Electrical Engineering

cnrs dépasser les frontières

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Marie Sklodowska-Curie grant agreement No 675318

1. Introduction
2. PV modeling
3. Preliminary Results
4. Common test cases
5. Following steps

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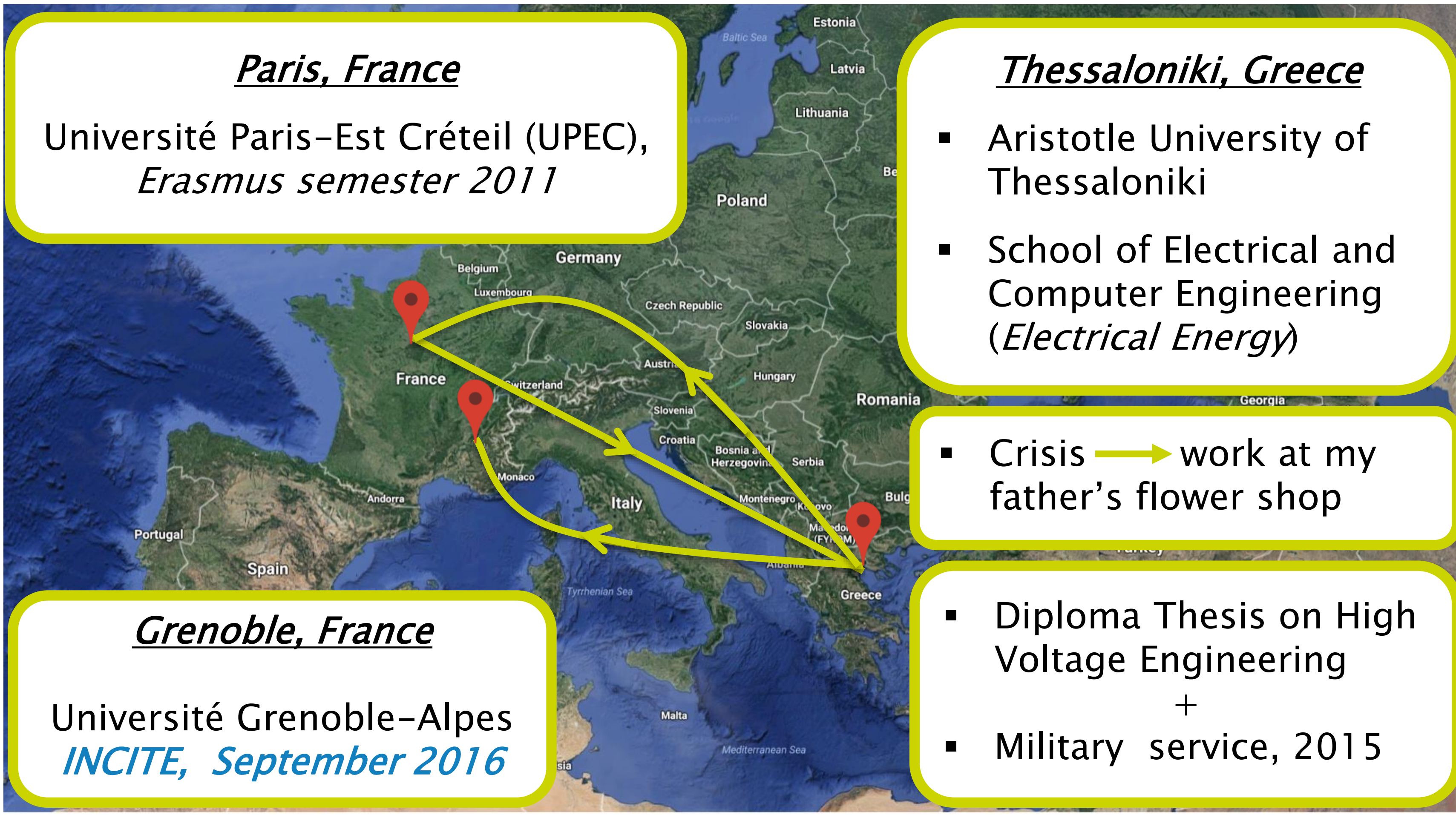
1. Introduction

about myself…



Paris, France

Université Paris-Est Créteil (UPEC),
Erasmus semester 2011

Thessaloniki, Greece

- Aristotle University of Thessaloniki
- School of Electrical and Computer Engineering (*Electrical Energy*)

- Crisis → work at my father's flower shop

- Diploma Thesis on High Voltage Engineering
+
- Military service, 2015

Grenoble, France

Université Grenoble-Alpes
INCITE, September 2016

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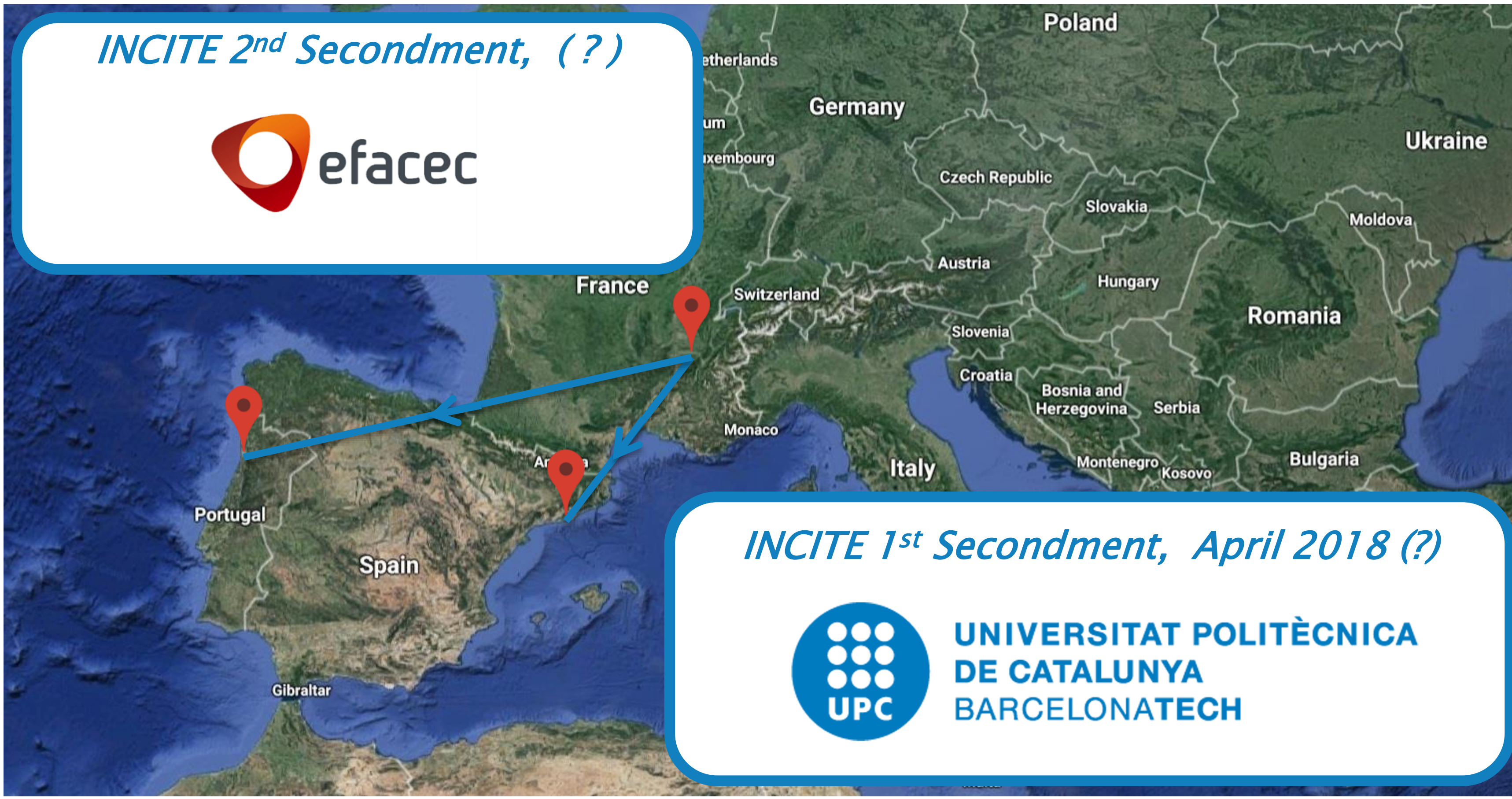
1. Introduction about myself…

INCITE 2nd Secondment, (?)

efacec

INCITE 1st Secondment, April 2018 (?)

UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH



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Main goal of this PhD...

...develop fault detection and isolation algorithms for the various modes of connection of power plants

...ensure high level availability of renewable power plants

↓

reduce the impact of outages

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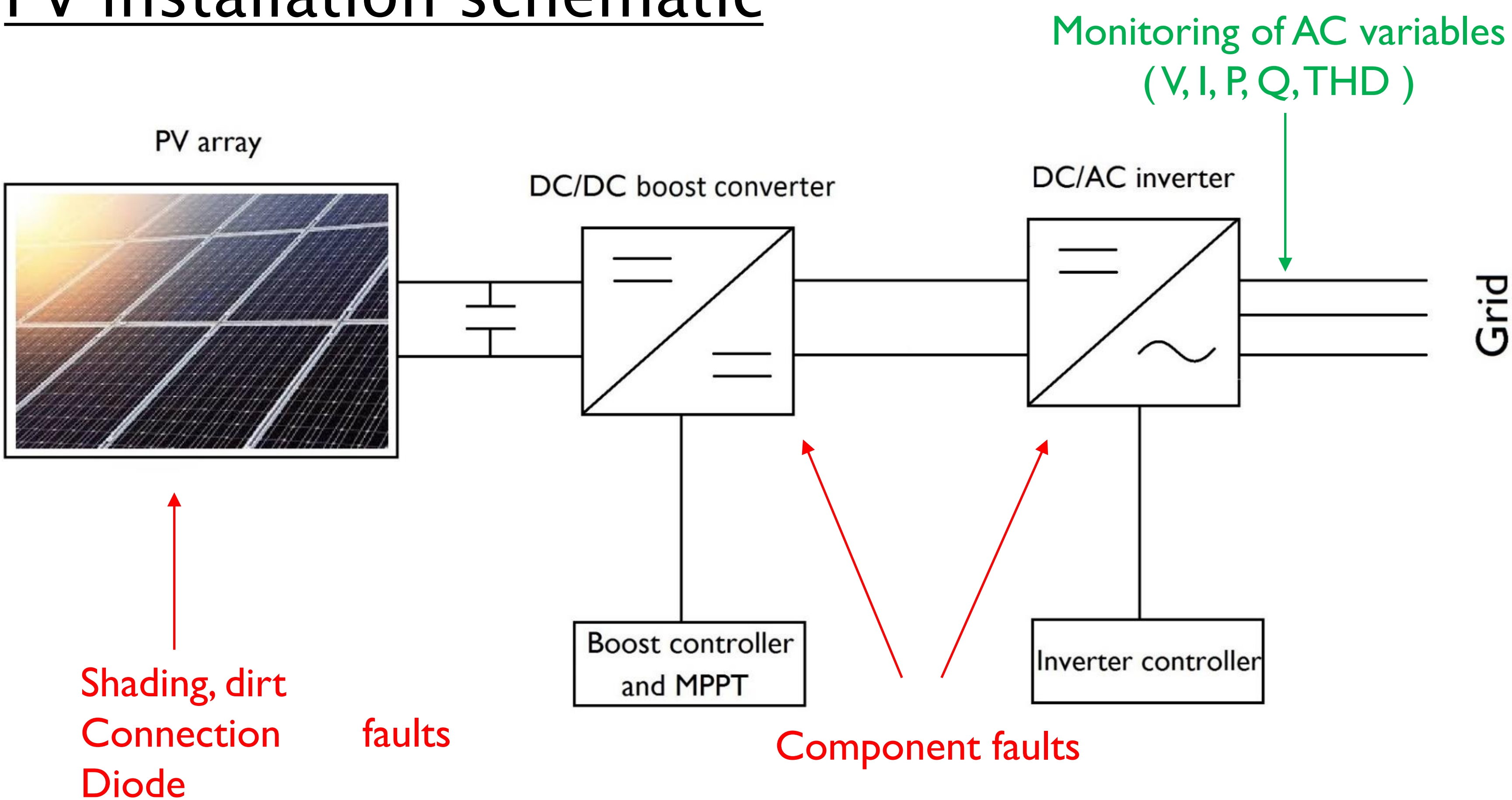
1. Introduction Objectives

PV installation schematic



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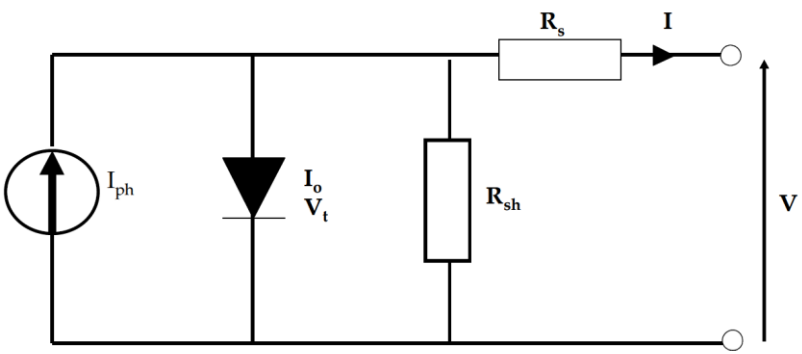
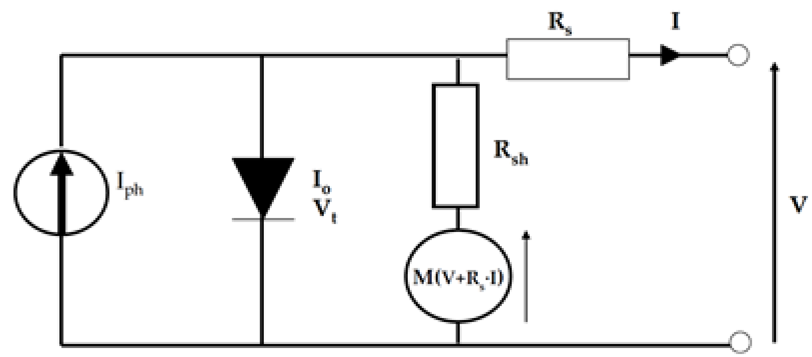
2. PV modeling — PV cell

PV equivalent models of 5 and 8 parameters



(a) One-diode model[1]



(b) Bishop's model[1]

$$I = I_{ph} - I_0 \cdot \left(e^{\frac{V+R_s \cdot I}{V_t}} - 1\right) - \frac{V + R_s \cdot I}{R_{sh}} \cdot \left[1 + k \cdot \left(1 - \frac{V + R_s \cdot I}{V_b}\right)^{-n}\right]$$

[1] D. Picault, "Reduction of Mismatch Losses in Grid-Connected Photovoltaic Systems Using Alternative Topologies", Ph.D. dissertation, Institut National Polytechnique de Grenoble - INPG, 2010.

incite

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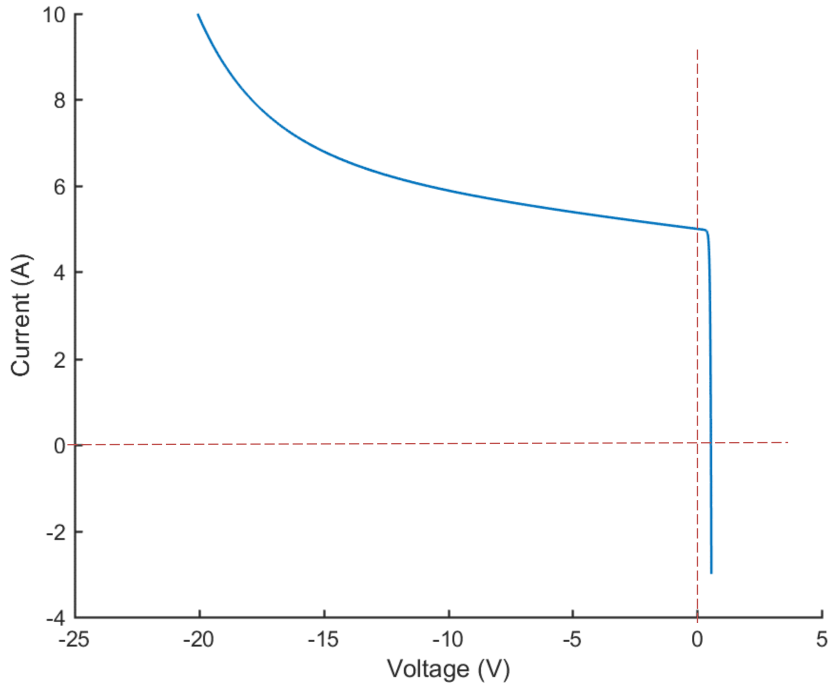
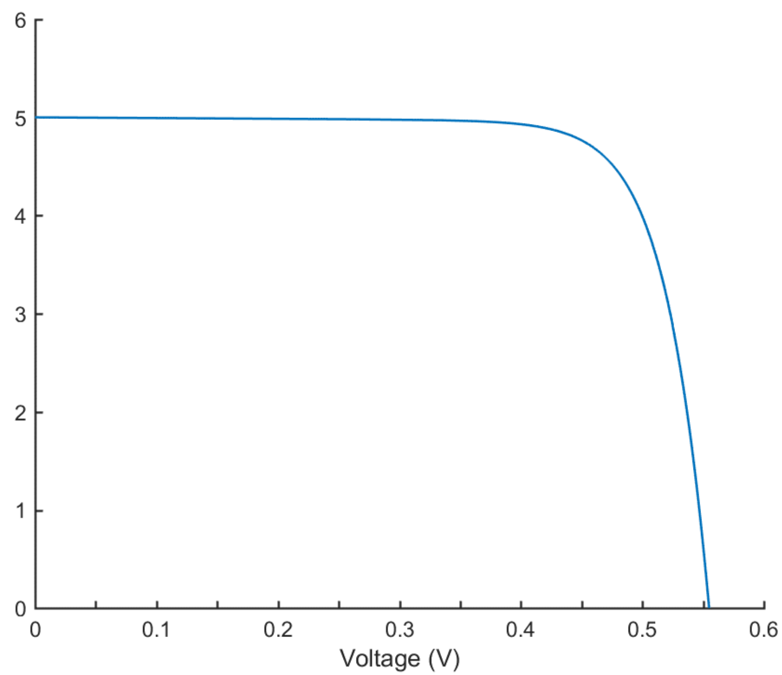
I–V curve of a PV cell

Full I–V curve



I–V curve (1st quadrant)



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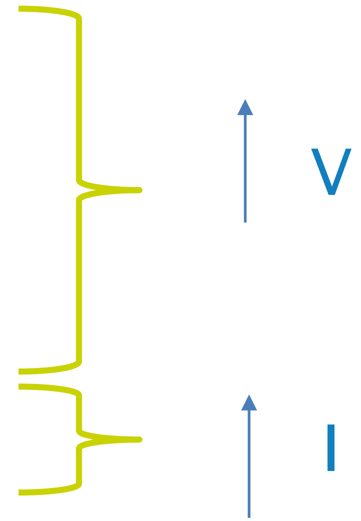
Creating a PV array

MATLAB

- Cell (basic unit)
- Module (multiple cells in series)
- String (multiple modules in series)
- Array (multiple strings in parallel)



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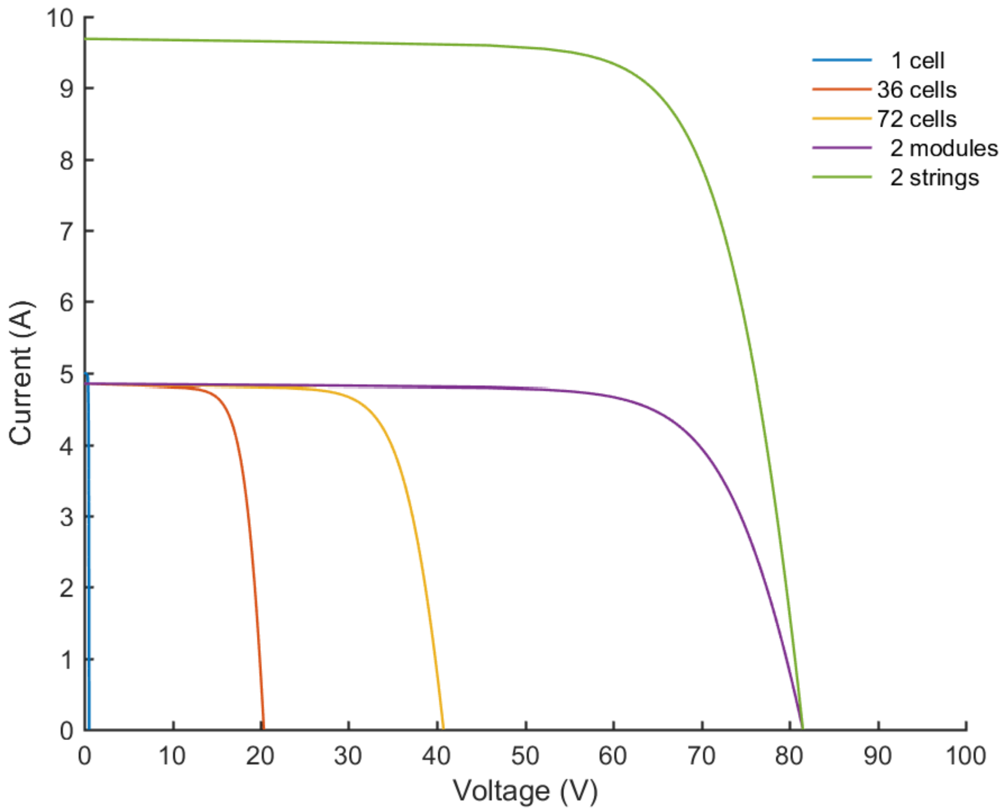
I–V curve of a PV array



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2. PV modeling Power Electronics

Averaged vs exact model

Averaged model of power converters: [in operation]

- omits the harmonics due to power switches
- considers the time dynamics of the fast variables to be instantaneous

Exact model: [almost finished]

- complete model for power converters
- control strategy for switches (PI controllers)

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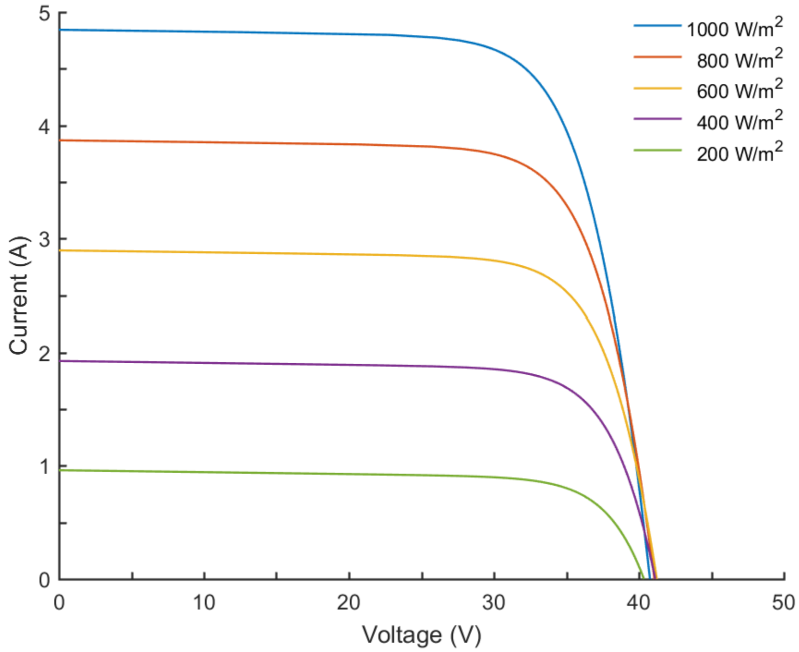
3. Preliminary Results

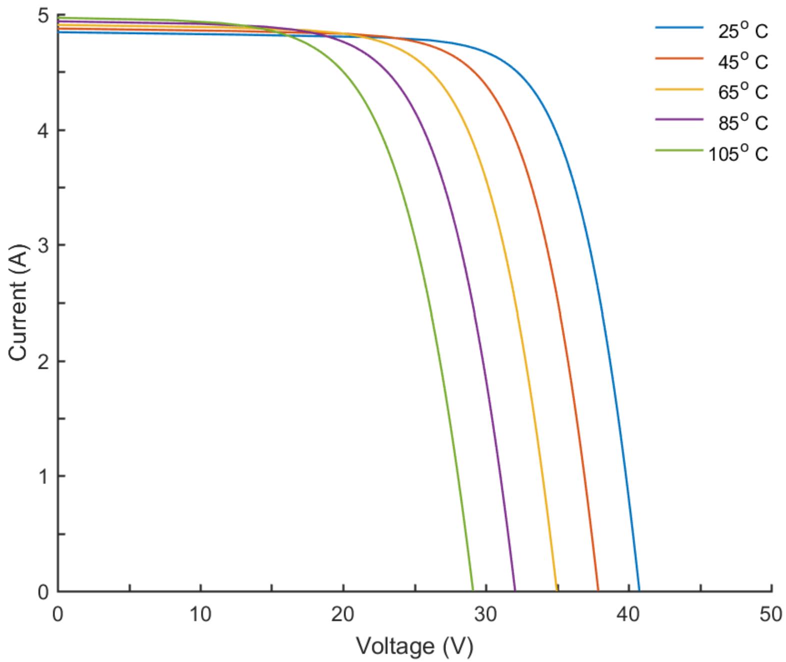
G, T

I–V curve of a PV module

Irradiance



Temperature



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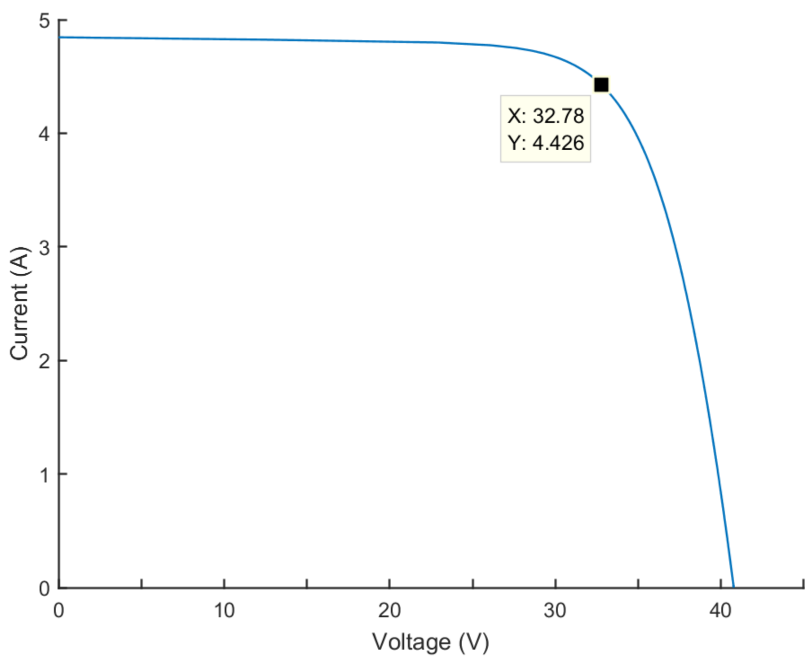
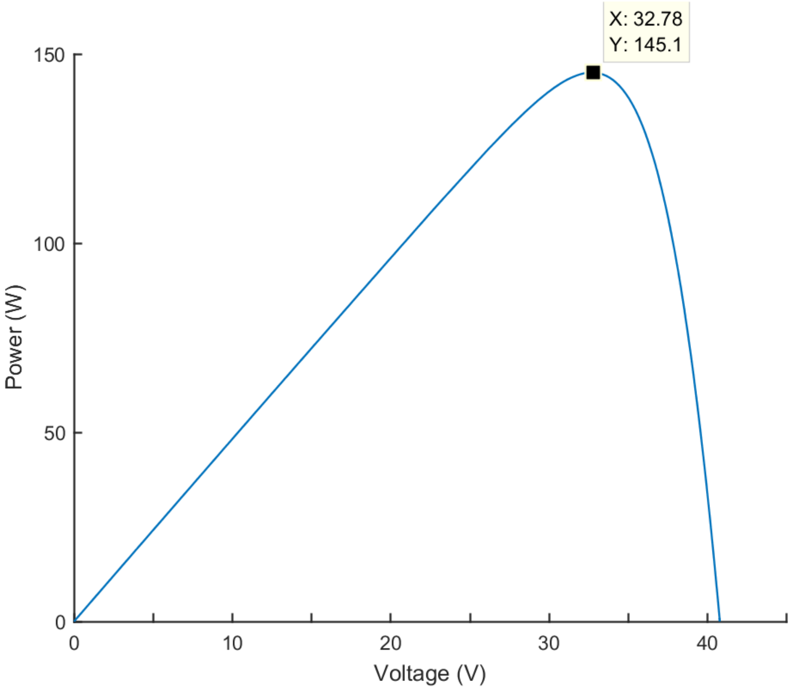
3. Preliminary Results

MPPT in PV





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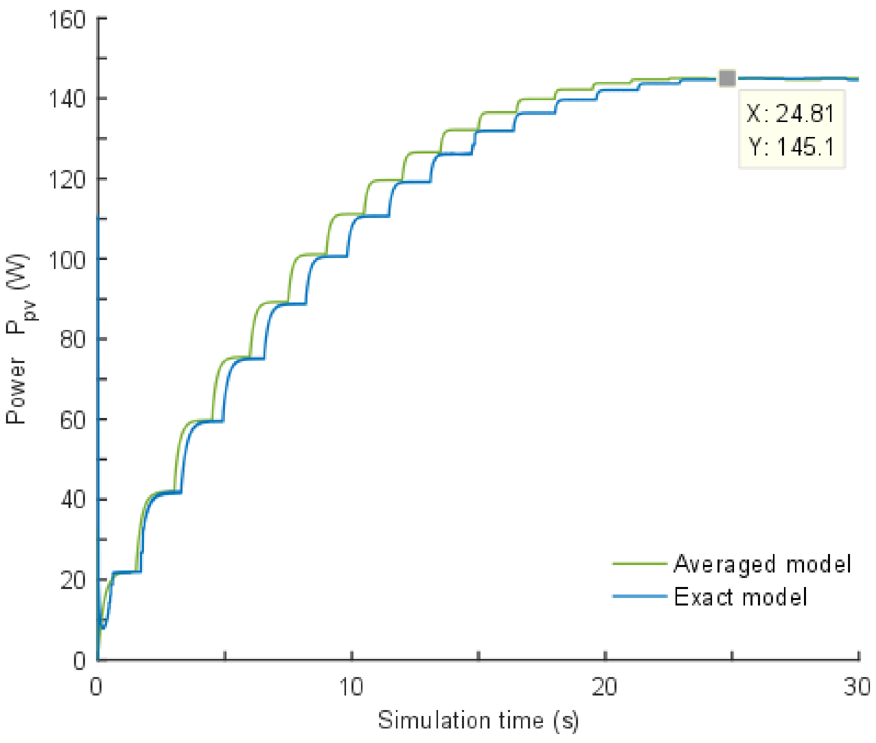
3. Preliminary Results MPPT

MPPT in PV under Averaged and Exact model



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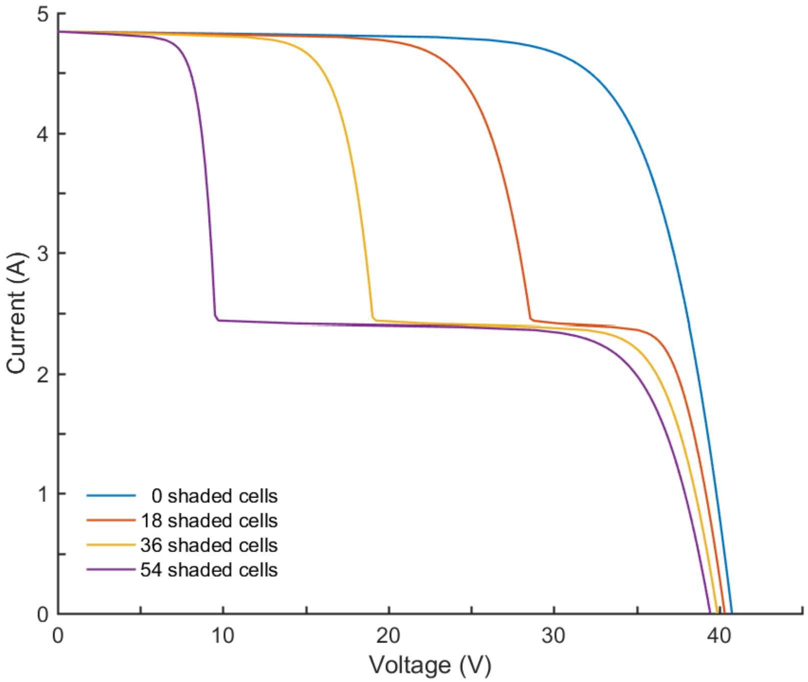
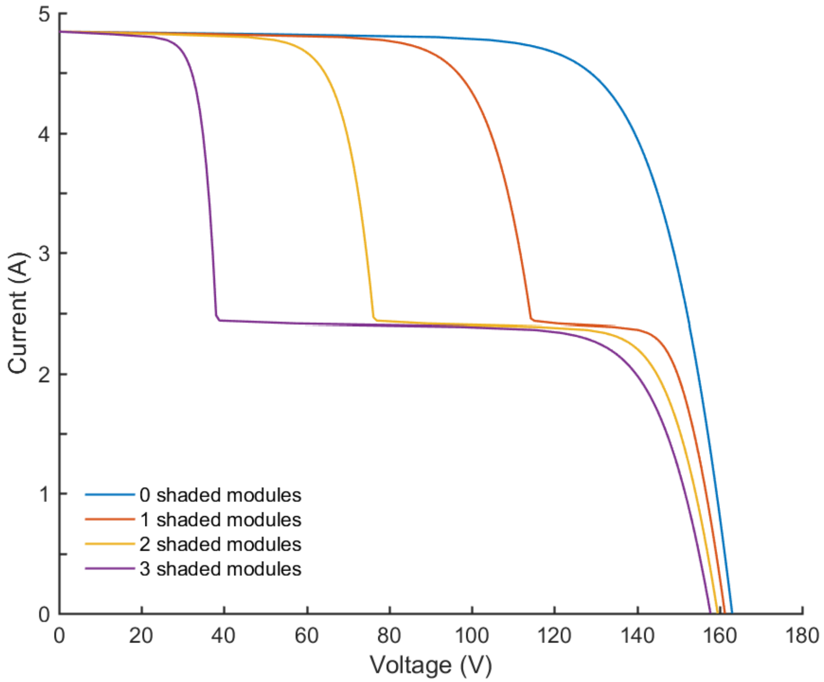
3. Preliminary Results

I–V curves under 50% shading

1 module with 72 cells



4 modules



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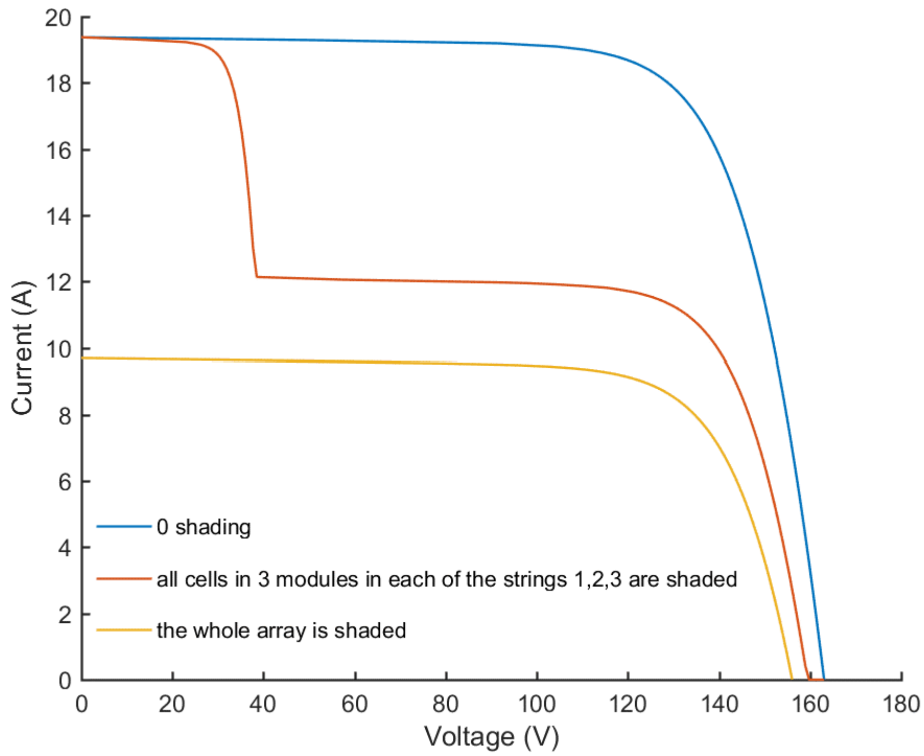
I-V curves under 50% shading



This PV array consists of:

- 4 strings
- 4 modules/string
- 72 cells/module

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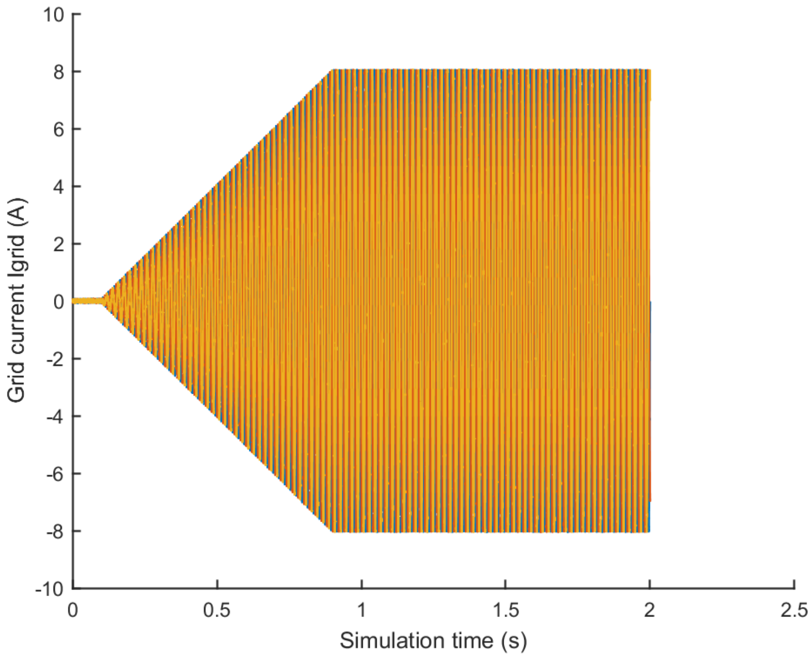
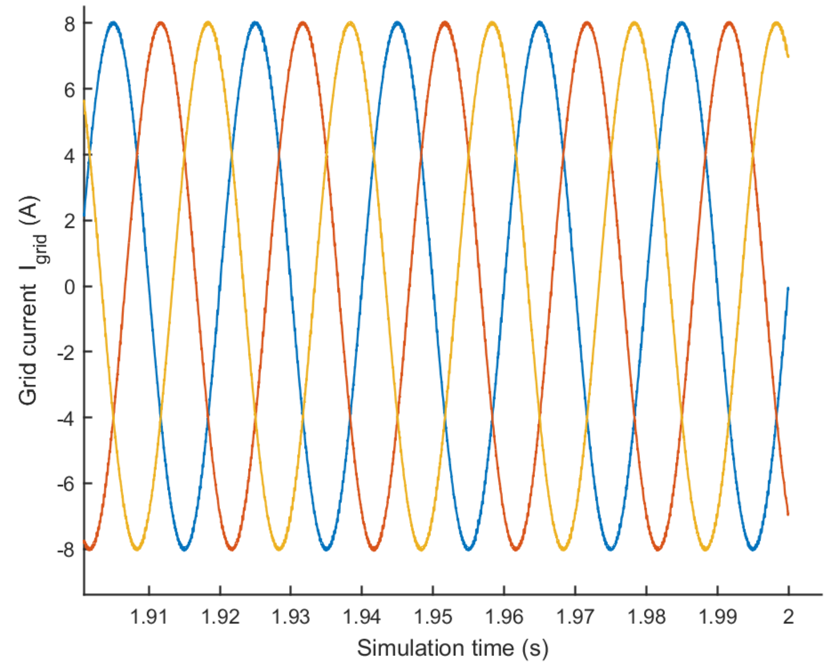
Control of grid current from the Inverter (exact)

Grid current control





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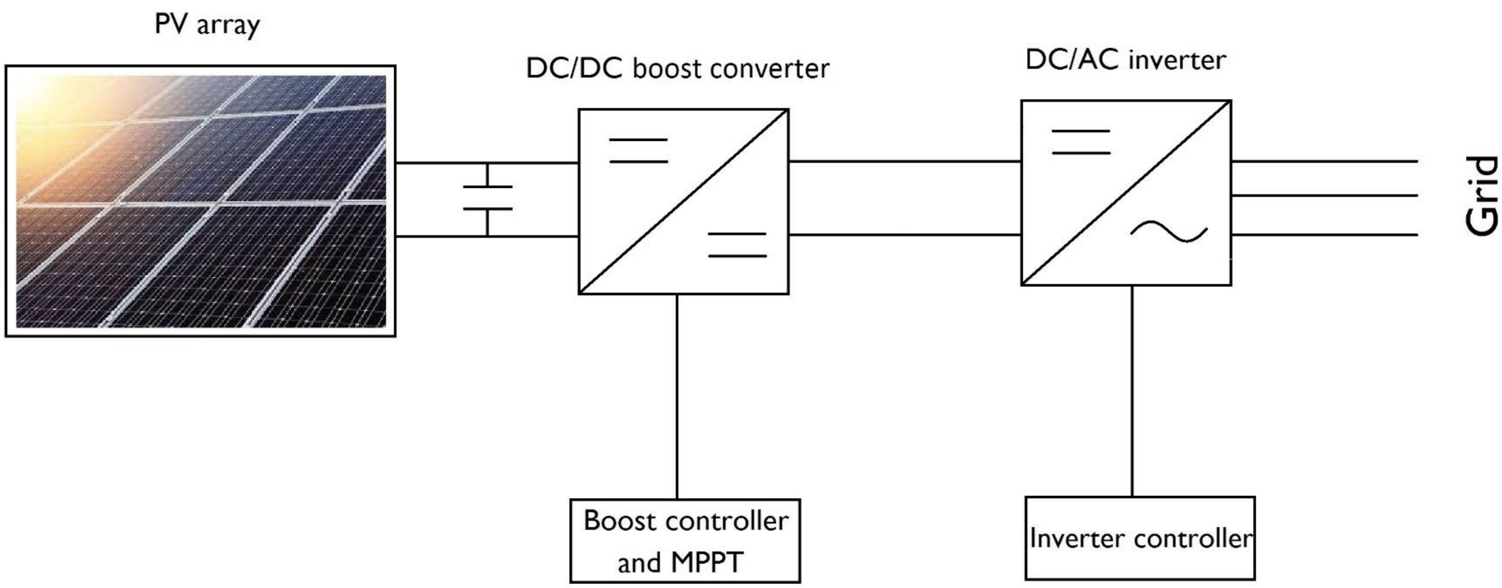
4. Common test cases PV

Photovoltaic model



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4. Common test cases Wind

Wind Turbine models

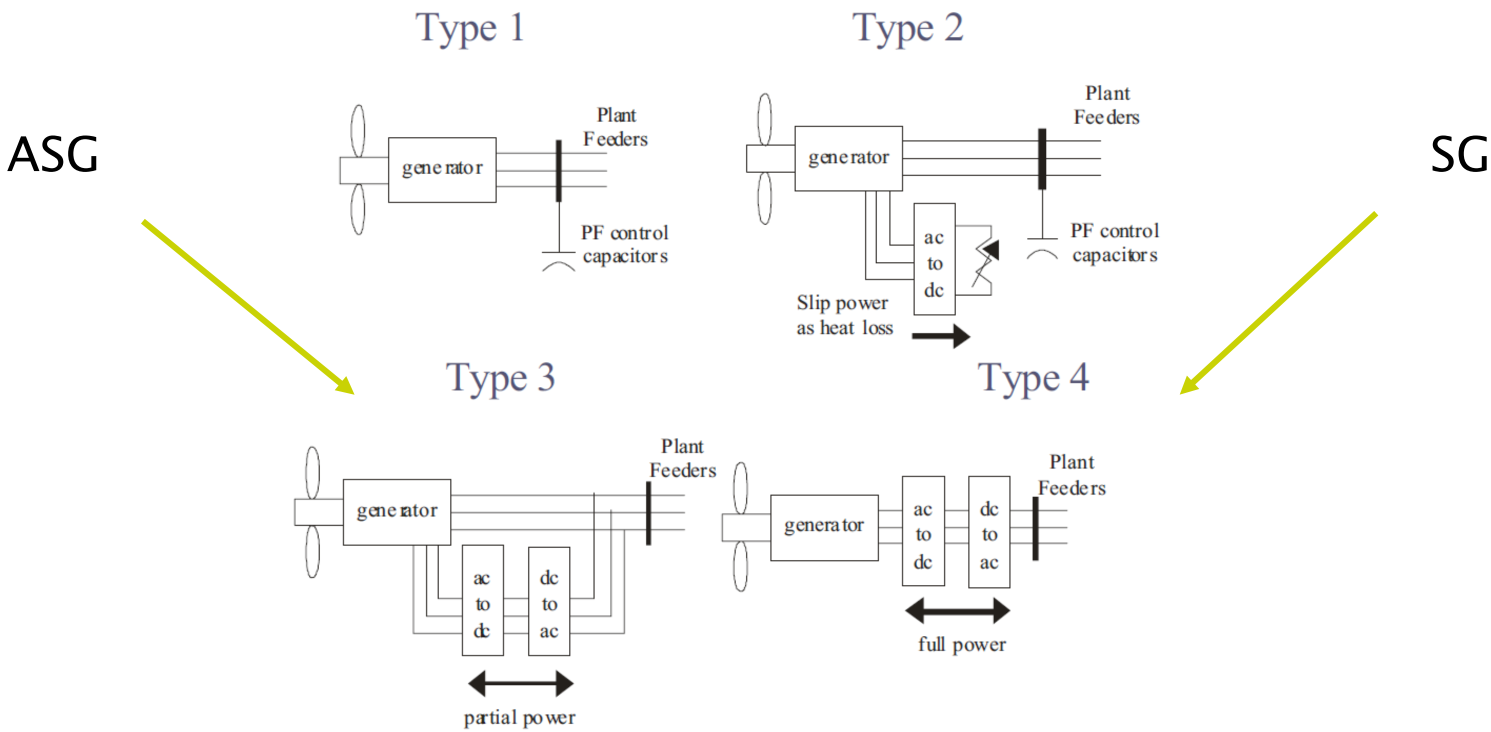

Figure from: M. Singh, E. Muljadi, and V. Gevorgian, “Test cases for wind power plant dynamic models on real-time digital simulator,” in *2012 IEEE Power Electronics and Machines in Wind Applications*, 2012, pp. 1–7.

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WP4 common test case

Decide the use of a common test case for Low Voltage Networks within the WP4.

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5. Following steps

1. Entire PV plant in normal operation
2. Study how different kinds of faults affect the plant.
3. Start the monitoring of AC variables (V,I,P,Q,THD).
4. Determine which faults can be detected from the AC side and which from the DC.
   - Location of the sensors
5. Develop a method to detect and isolate faults:
   - model approach or signal approach.
6. Start the modelling of wind turbine.

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Thank you for your attention !

Any Questions ?

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