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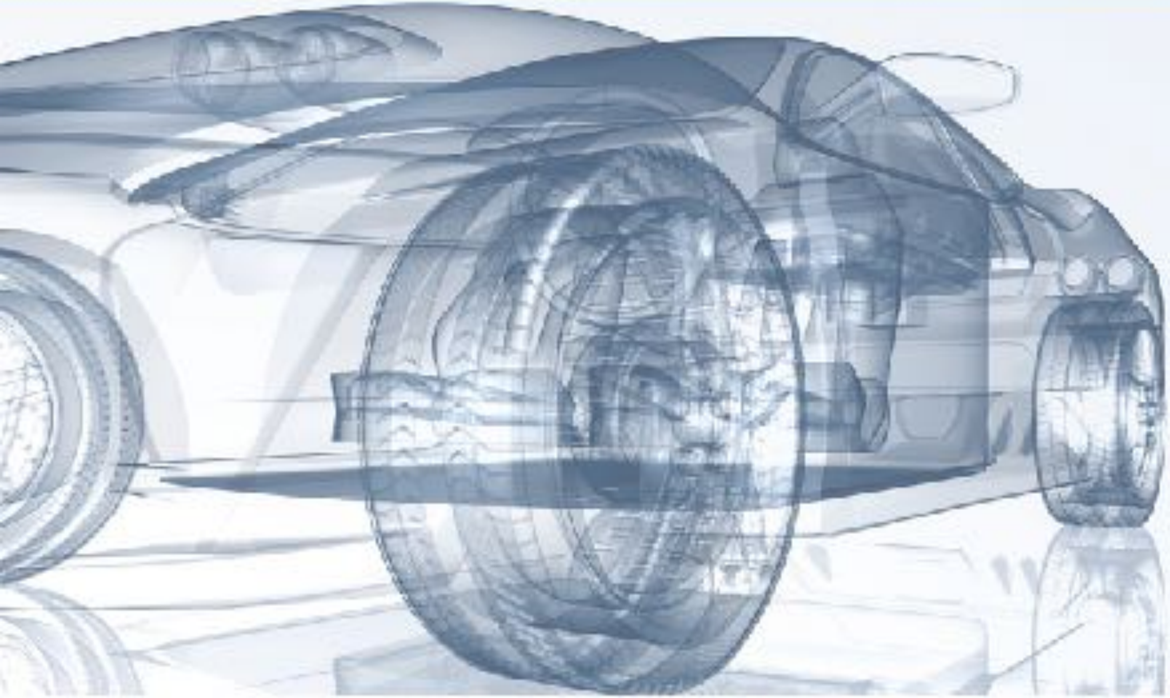

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Intelligent photovoltaic-grid system for electric vehicles charging station

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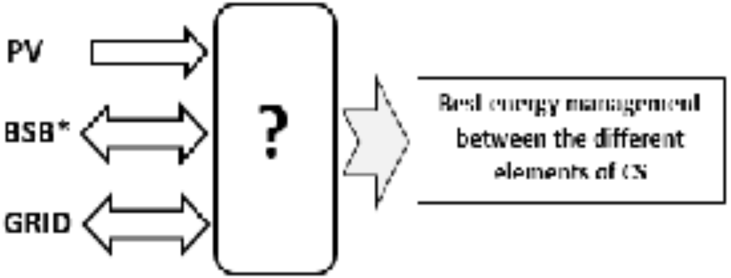
Outline

I. Introduction
II. Problematic & challenges
III. Architecture & Approaches
IV. Results & Discussion
V. Conclusion

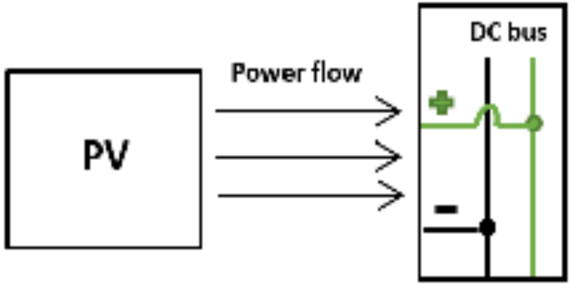
Introduction

- This work focuses on power management of electric vehicle charging stations supplied by multiple energy sources.
- The photovoltaic power is enhanced using algorithms for loading a buffer storage system i.e. lithium-ion battery.
- The contribution of the Grid is added in the platform with a bi-directional flux of power.
- A management algorithm takes into account the state of charge of the batteries and the state of the DC link, as main inputs of the controller unit. The outputs are commands to the power switches.
- A Predicted power flow!

Problematic & Challenges



Challenge N°1

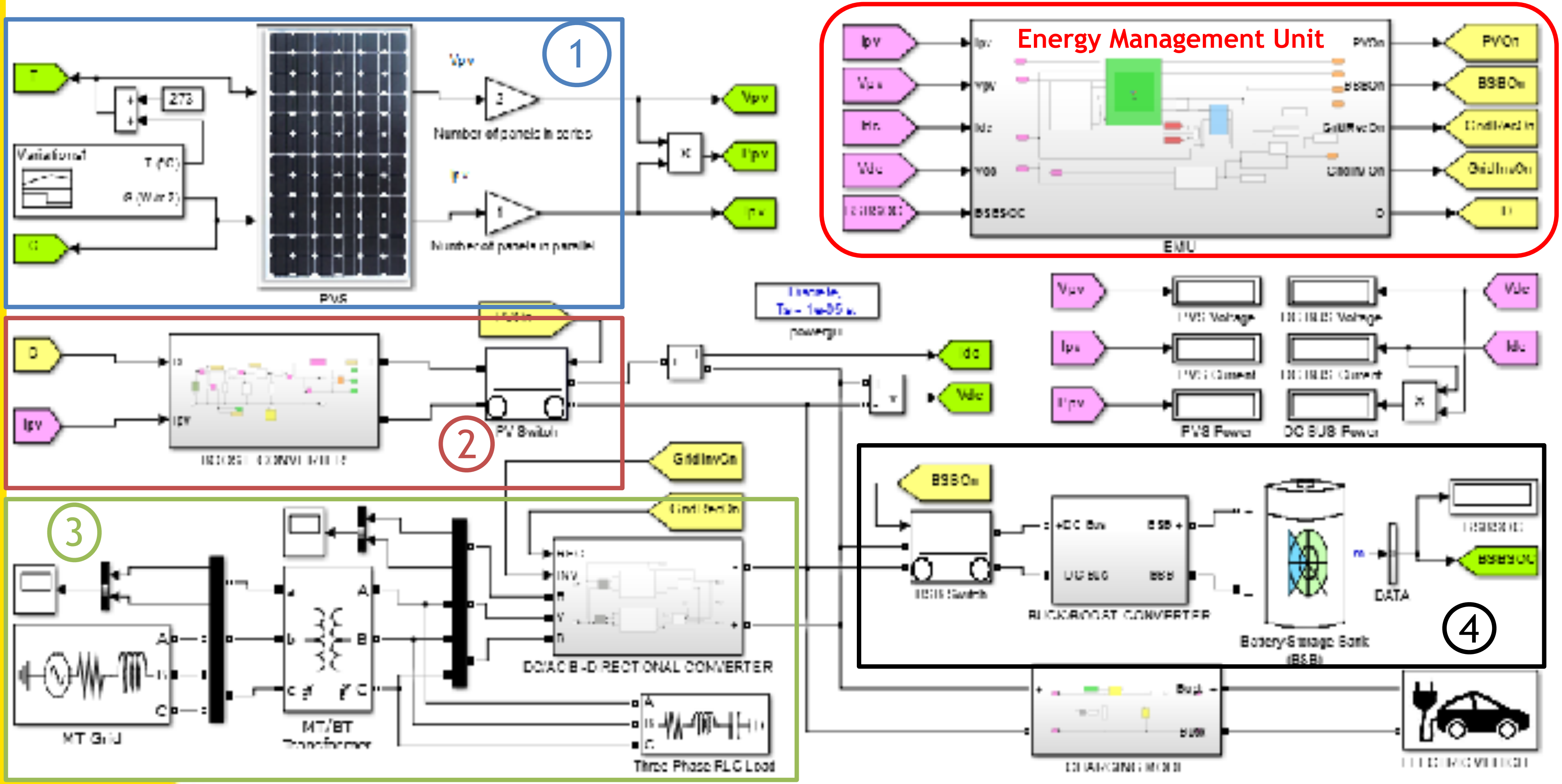


Challenge N°2

- The random efficiency of photovoltaic energy due to the changes in temperature and irradiance.
- The instability of the DC bus power.

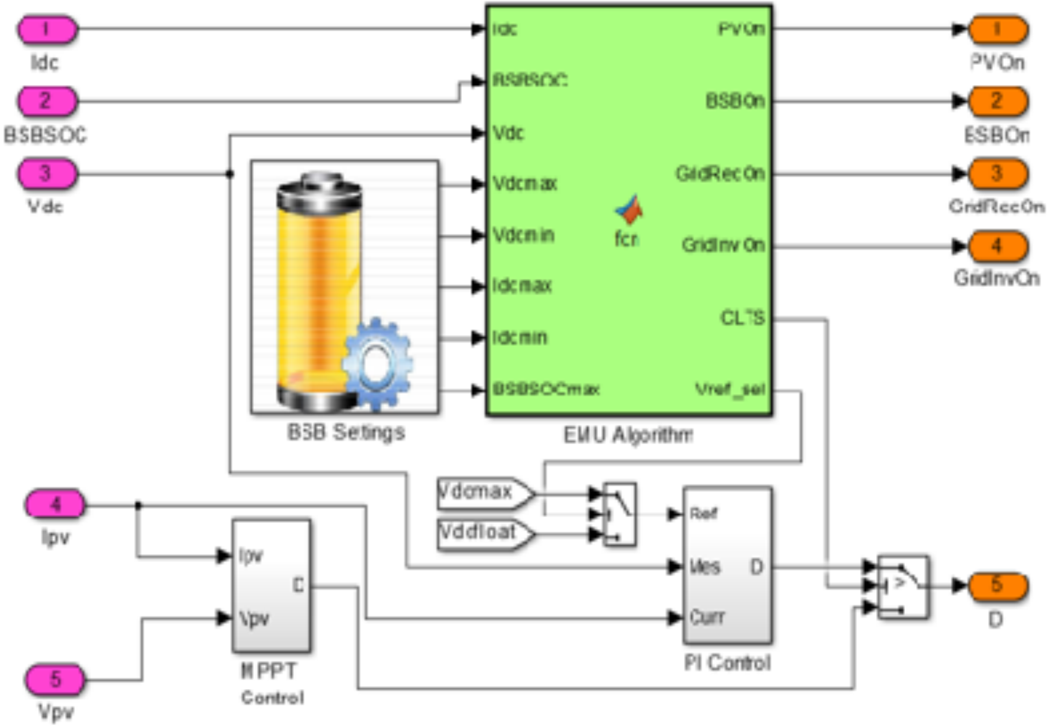
BSB: Battery Storage Buffer

Architecture & Approaches



Architecture & Approaches

- The measurement of current and voltage of the DC bus and the SOC of BSB are the main input of the EMU*.
- One of the two controls (MPPT & PI) is selected according to the DC link state.

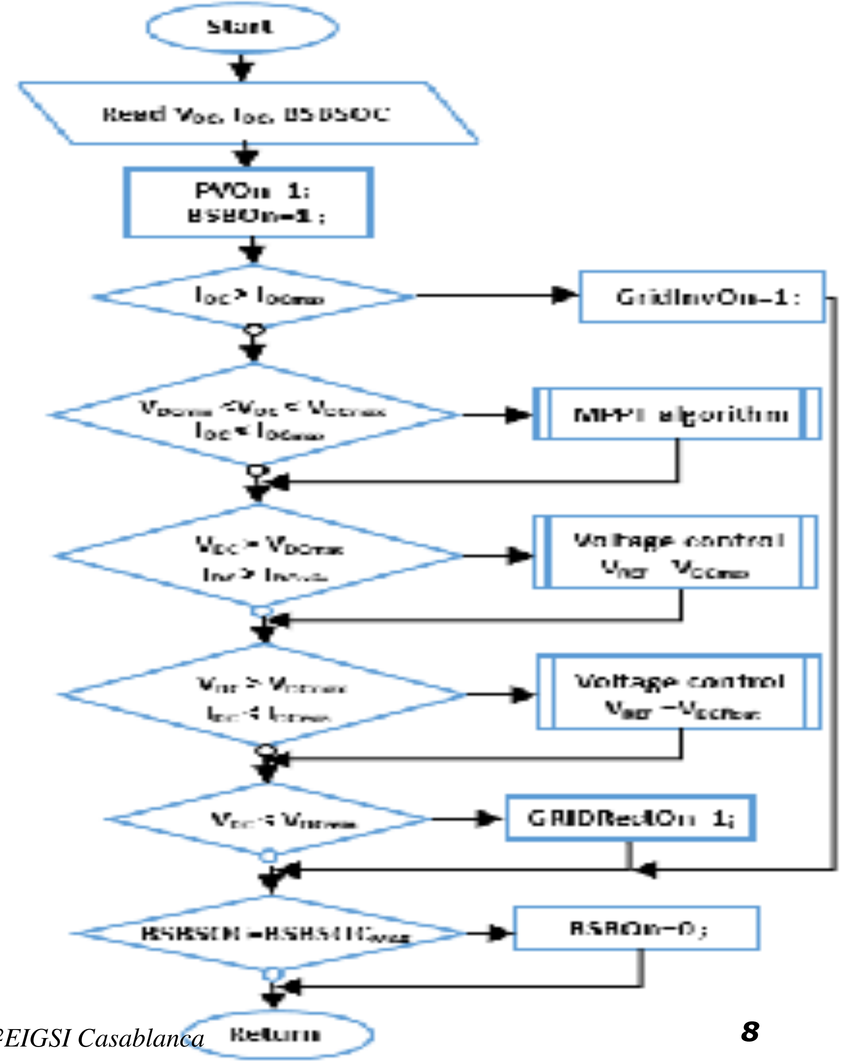


Internal diagram of energy management unit of the PV-Grid system

EMU: Energy Management unit

Architecture & Approaches

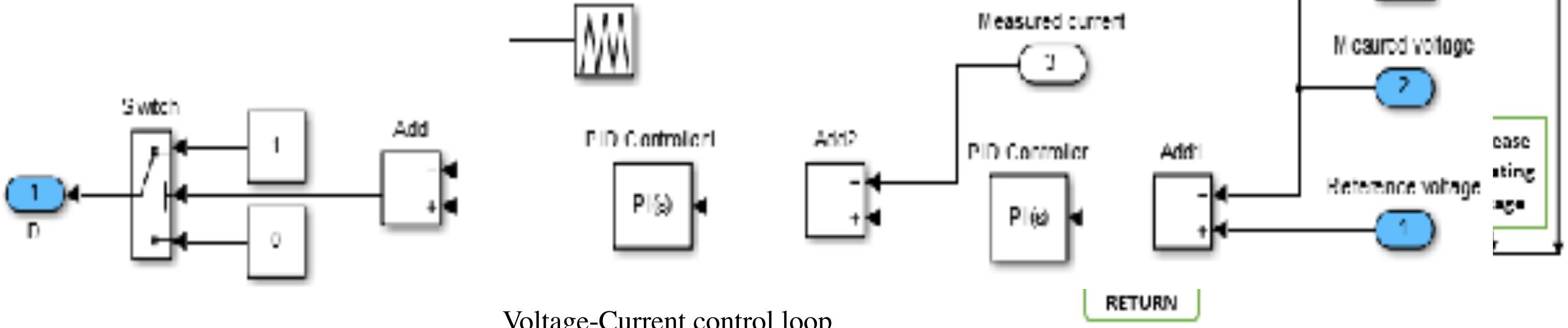
- Flowchart of the energy management approach with access to power switches
- Initialisation of the program with the dynamic state of BSBSOC, Vdc and Idc.
- The “Loop if” role is to maintain the energy balance of the charging system.
- Monitoring the power flow with access to duty cycle of the boost converter.



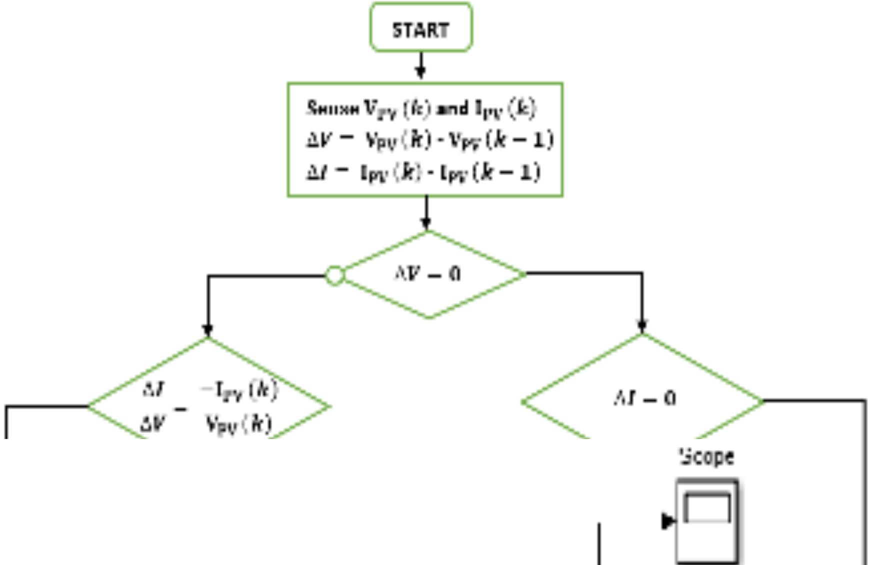
Architecture & Approaches

- Recent literatures point that INC has a good compromise between performance and complexity of implementation.

- The goal of the control loop is to avoid sudden degradation of battery performances, by protecting it from a higher current and voltage delivered by the PV system.



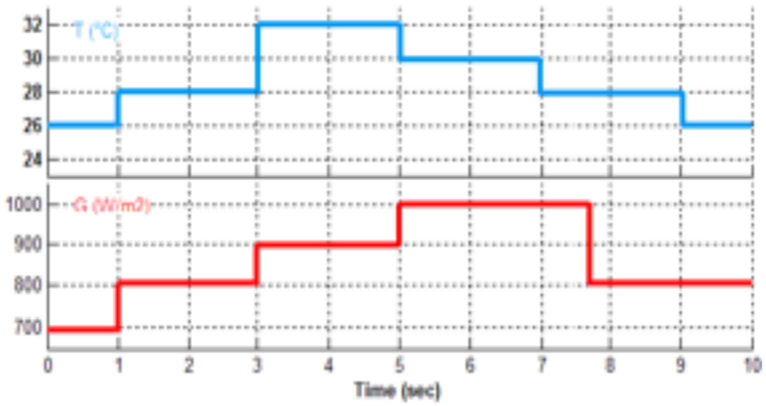
Voltage-Current control loop



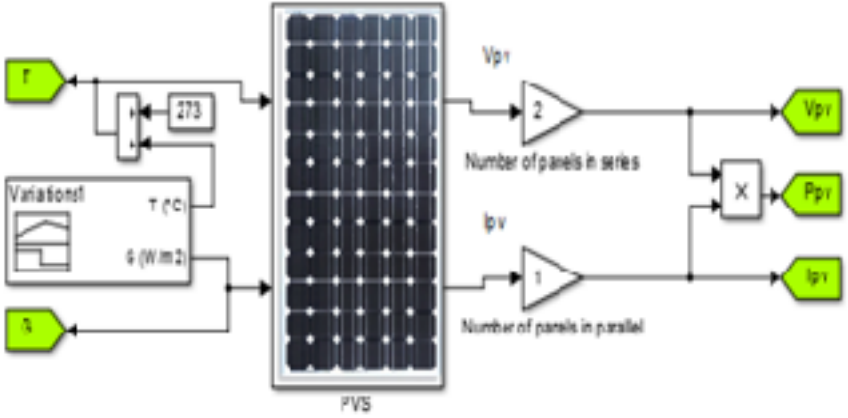
Flowchart of the INC* MPPT method

INC: INcremental Conductance

Results & Discussion



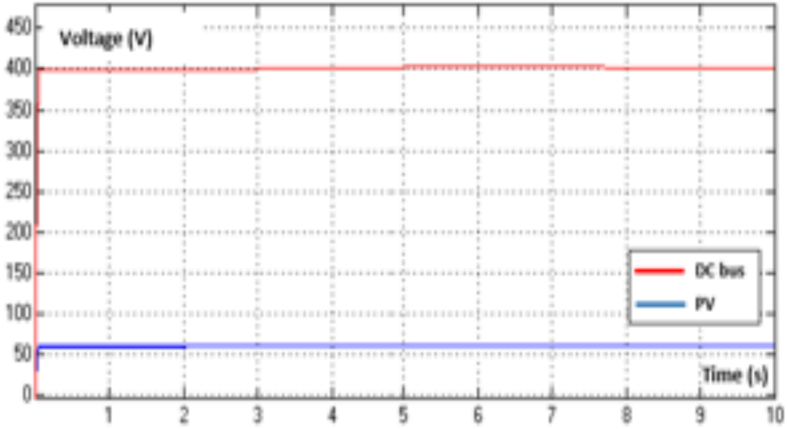
Meteorological scenario of solar irradiation and temperature



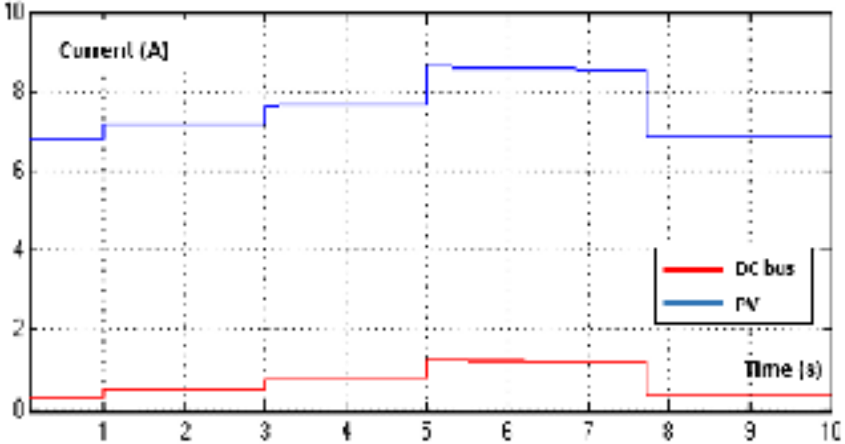
Global design of PV array

- ❑ A scenario case implemented in PV inputs
- ❑ A temperature and irradiation margin must respect the typical values delivered on a sunny day.

1. Photovoltaique stand-alone



DC bus voltage of the system versus time

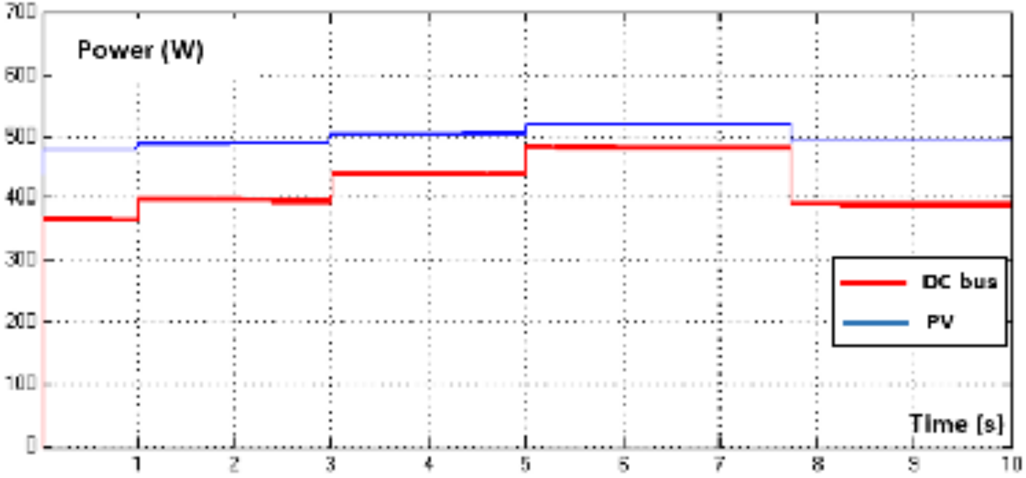


DC bus current of the system versus time

- PVOn, BSBOn are activated to generate the ordinary charging process of the BSB.
- The BSB is loaded under a stable voltage value despite the input perturbations of the created climate scenario
- The PV system current corresponds exactly to the variation of irradiation.

Results & Discussion

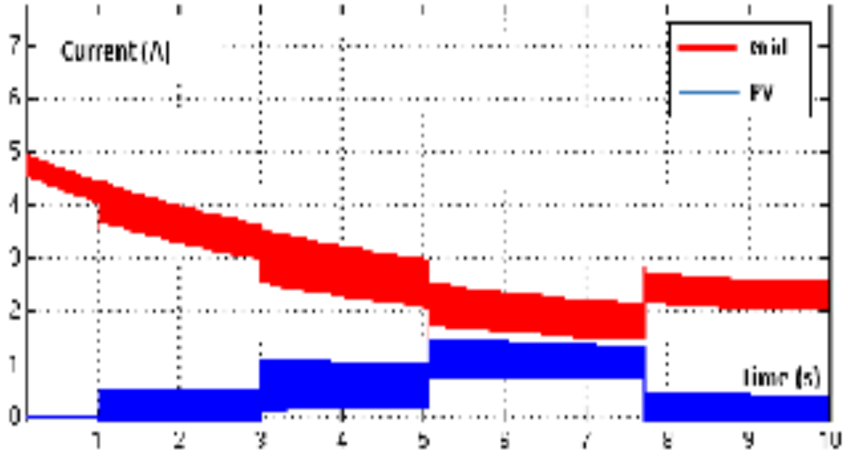
1. Photovoltaique stand-alone



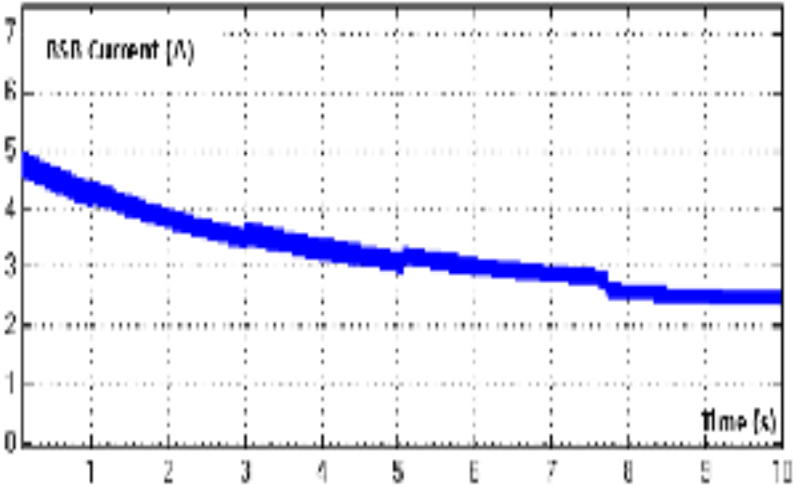
Charging station DC power versus time

- The power of the DC bus converges to the PV output power
- The energy losses are related to the energy conversion in the boost chopper.

2. Photovoltaique & Grid



Grid/PV current versus time

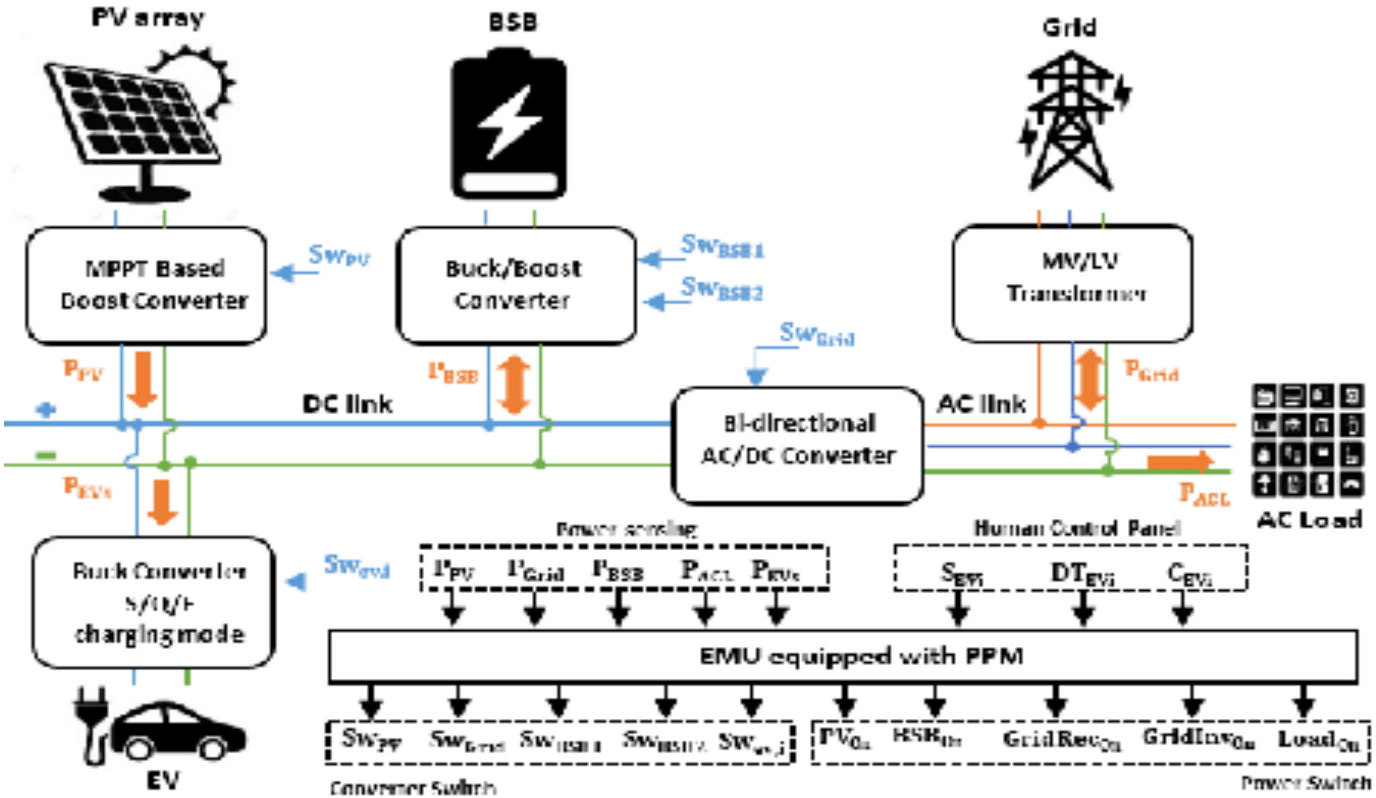


BSB charging mode versus time

- PVOn, BSBOn and GridRecOn are activated to compensate the lack of PV power.
- The current at the boost output is added to that of the electrical network.
- The current consumed by the BSB is decreased due to the increasing value of its state of charge.

Results & Discussion

Power Predictive Model (PPM)



Conclusion

- Simulation results shows the proposed control strategy.
- The controls generated from the EMU made a balance of energy between power demanded and supplied.
- The AC additional load is presented as an extra burden on the system to test the stability of the DC link.
- HCP set the EMU to predict a power flow scenario of the available energy sources for a plugged-in EV battery.

Thanks for your attention

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Results & Discussion

Power Predictive Model (PPM)