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Solar Charging Station

By
Nadeem Baza

INTERN AT L2EP / MASTER'S STUDENT
(YEAR 1) AT THE UNIVERSITY OF LILLE

Supervisors

Florian Tournez

Walter Lhomme



MOUVE : MObility and Use of electric VEhicles based on dedicated charging infrastructure

Outline

- 1 Setup on the eV Platform
- 2 System Components
- 3 Conclusion



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Setup on the eV Platform

eV platform



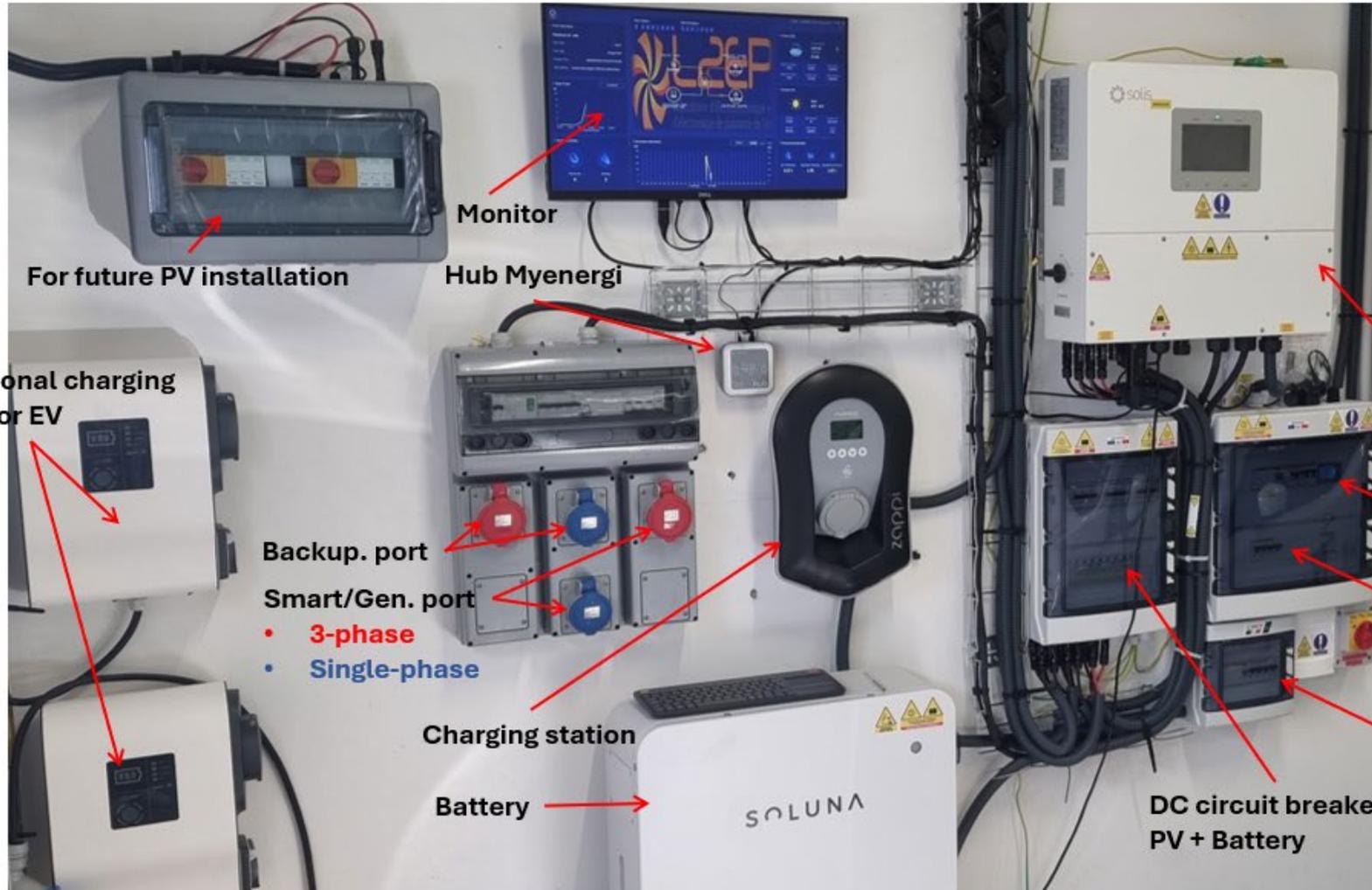
Installed system



Installation on the roof of the building

34 solar panels

14.5kW



For future PV installation

Monitor

Hub Myenergi

Conventional charging station for EV

Backup. port

Smart/Gen. port

- 3-phase

- Single-phase

Charging station

Battery

Converter DC-DC + Inverter DC-AC

Smart meter

AC circuit breakers (Inverter output + Grid)

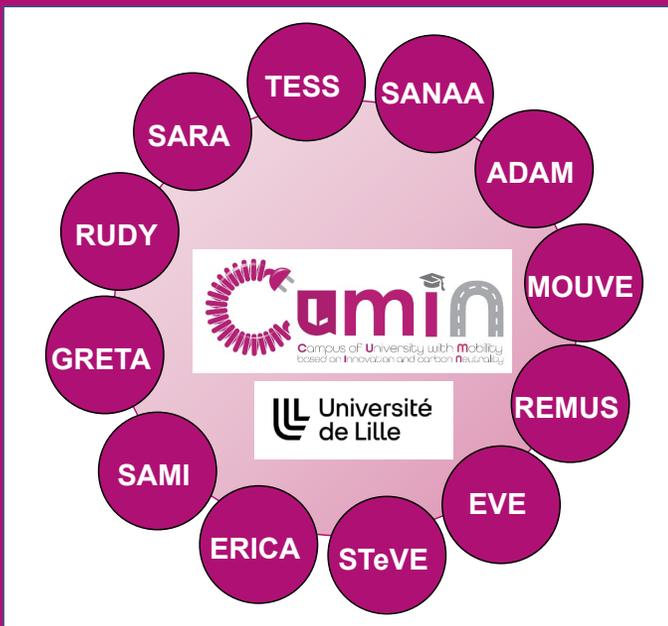
AC circuit breakers (Charging station)

DC circuit breakers PV + Battery

EV Charging Platform Installation



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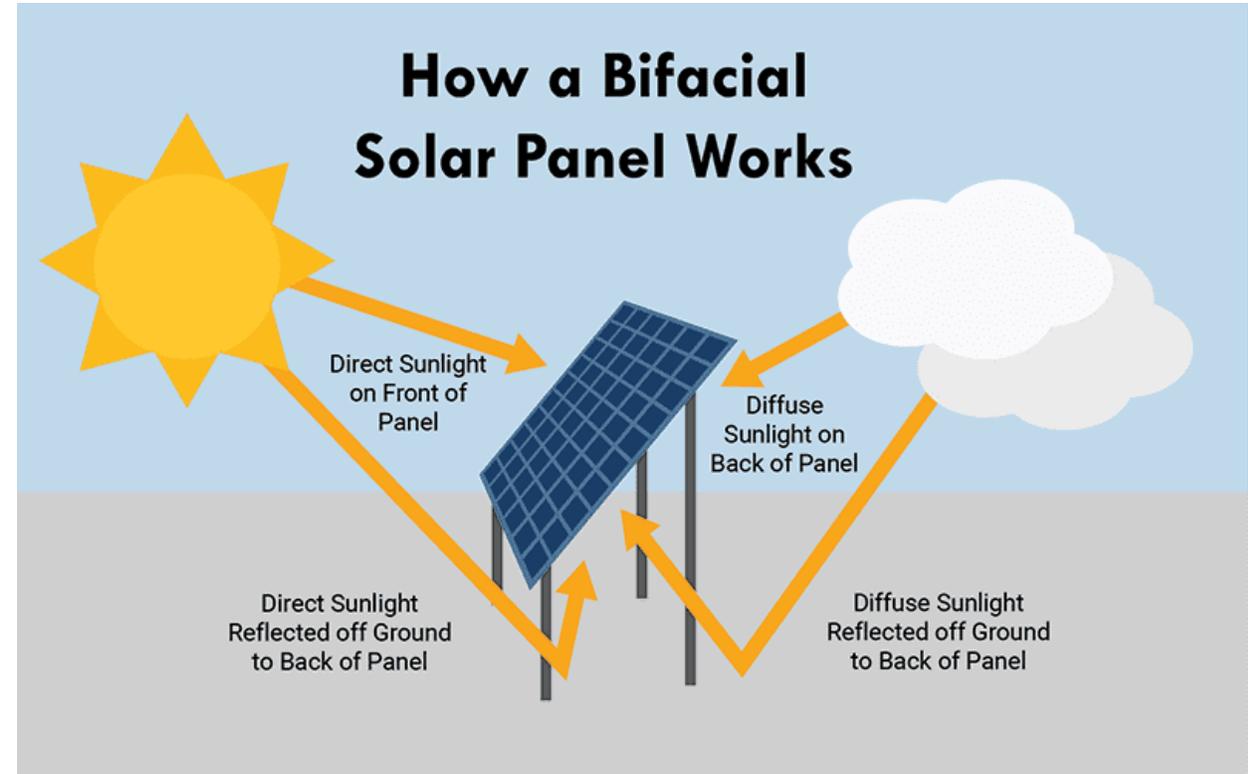
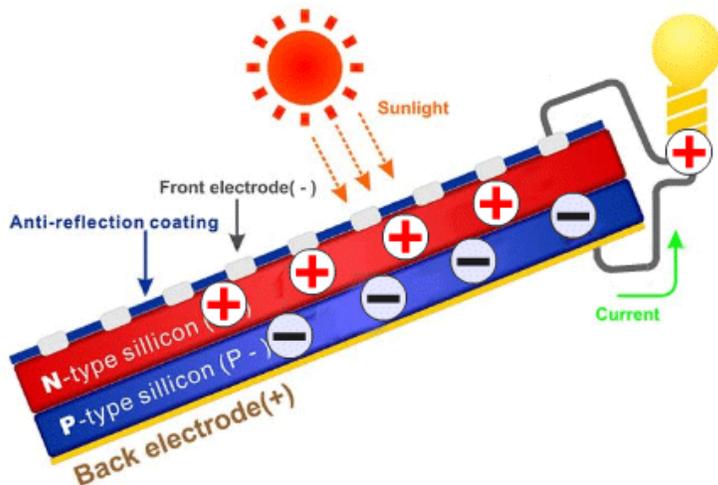
System Components

Solar panel

❖ SPR-P7-428-BLK bifacial solar panel (Sunpower)



Installation on the roof of the ESPRIT building



<https://www.nextenergy.my/bifacial-pv-panels-is-it-worth-all-the-hype/>

Bifacial design (+50W)

Eff.21%

428W

TOPCon cell technology

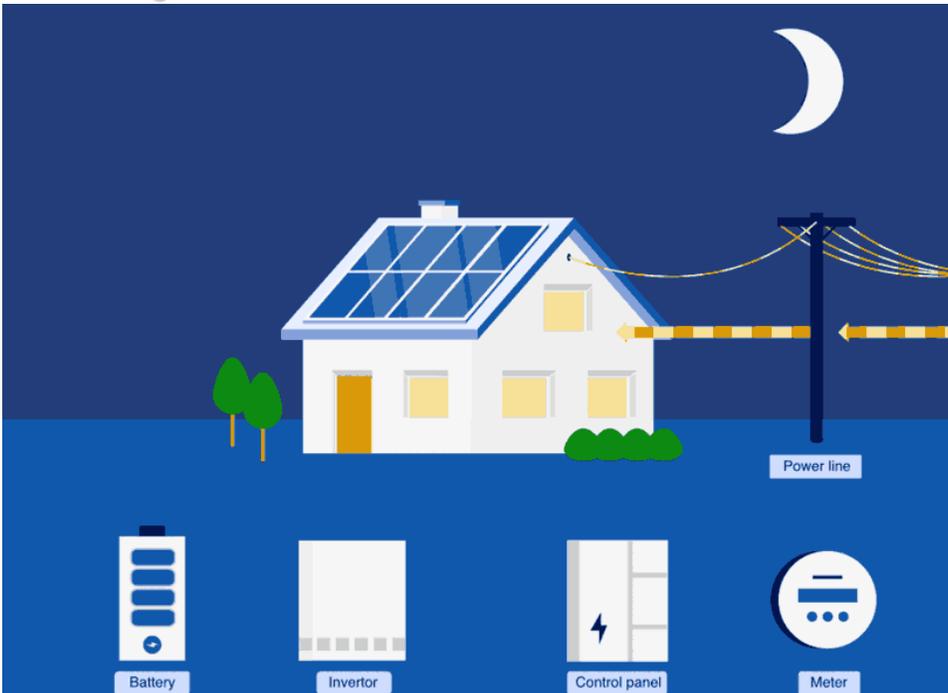
Tunnel Oxide Passivated Contact

High Voltage Battery Pack & Charging Station

❖ Soluna 10kWh Pack HV



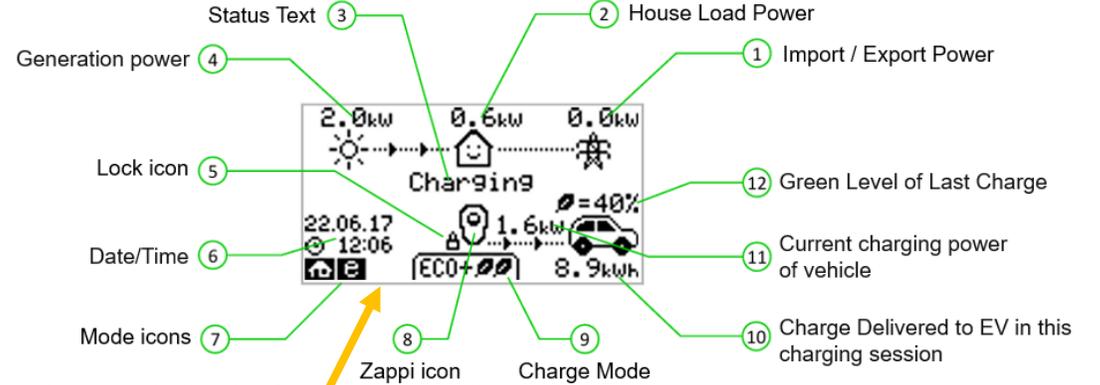
- LFP
- Eff. 95%
- 280V
- 30A
- >3600 life cycles



A Possible scenario to use the battery

<https://www.comparethemarket.com.au/energy/solar-batteries/>

❖ ZAPPI-222UB-T



Fast, ECO, ECO+

22kW

Grid-to-Vehicle (G2V)



Off-grid station mode

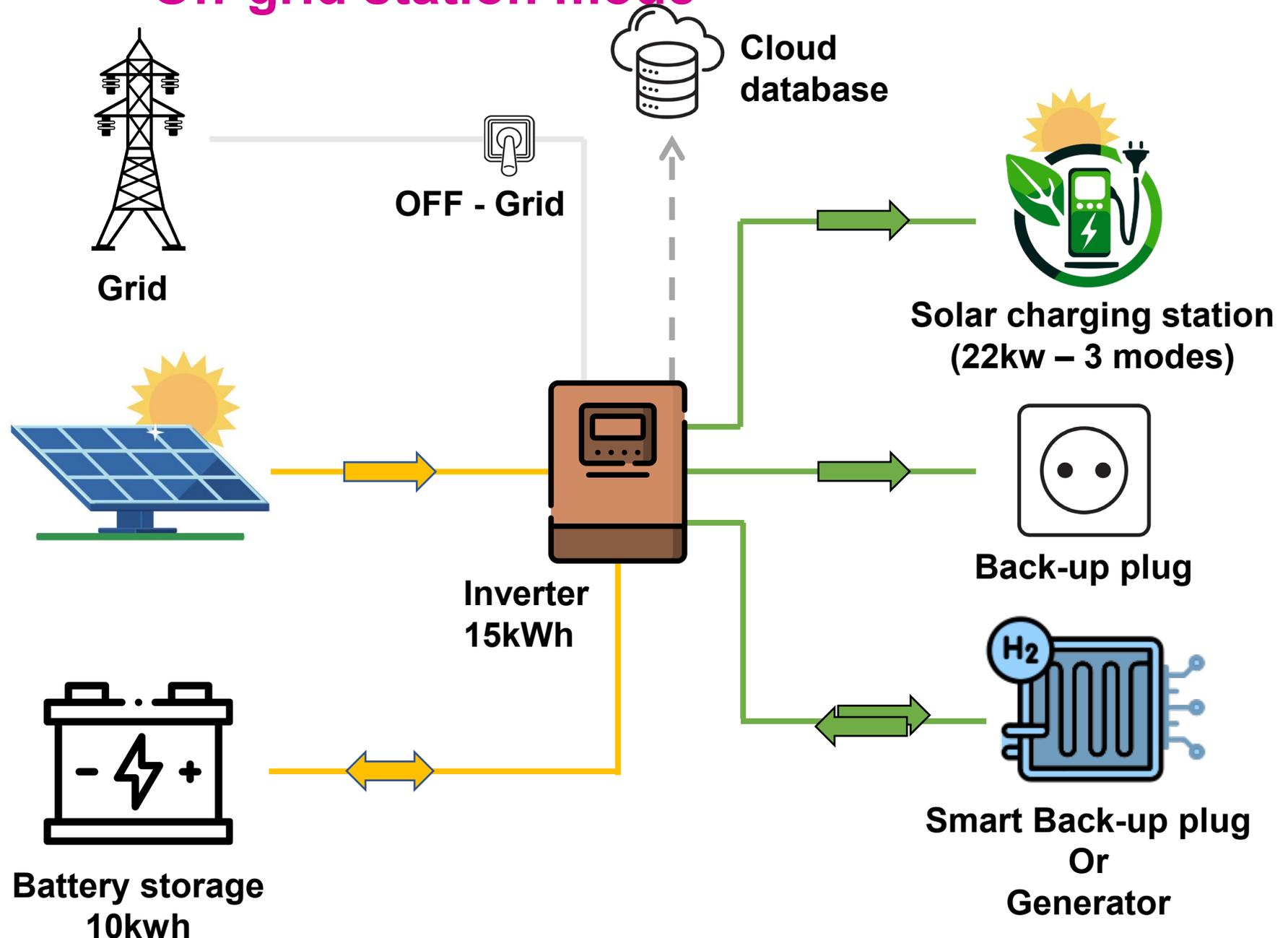
❖ Solis inverter



15kW 4MPPTs

Maximum Power Point Tracking

Extract the maximum possible power from PV panels



On-grid charging mode

❖ Solis inverter

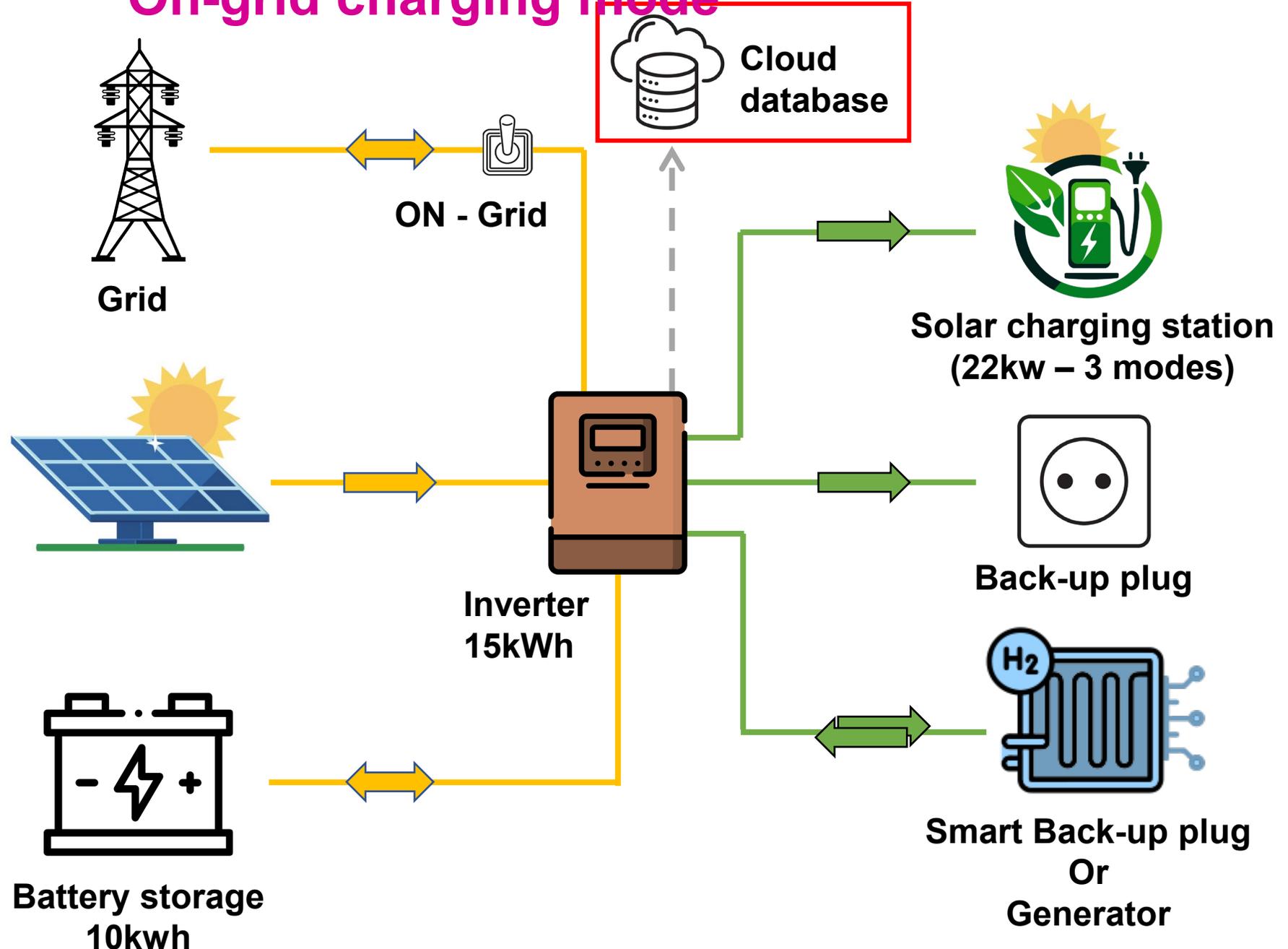


15kW

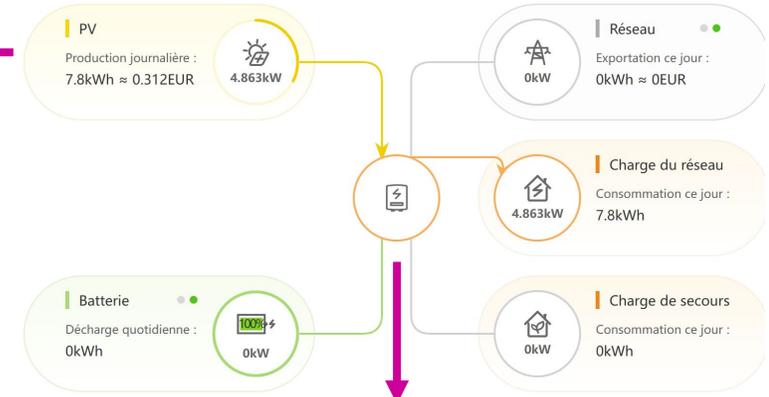
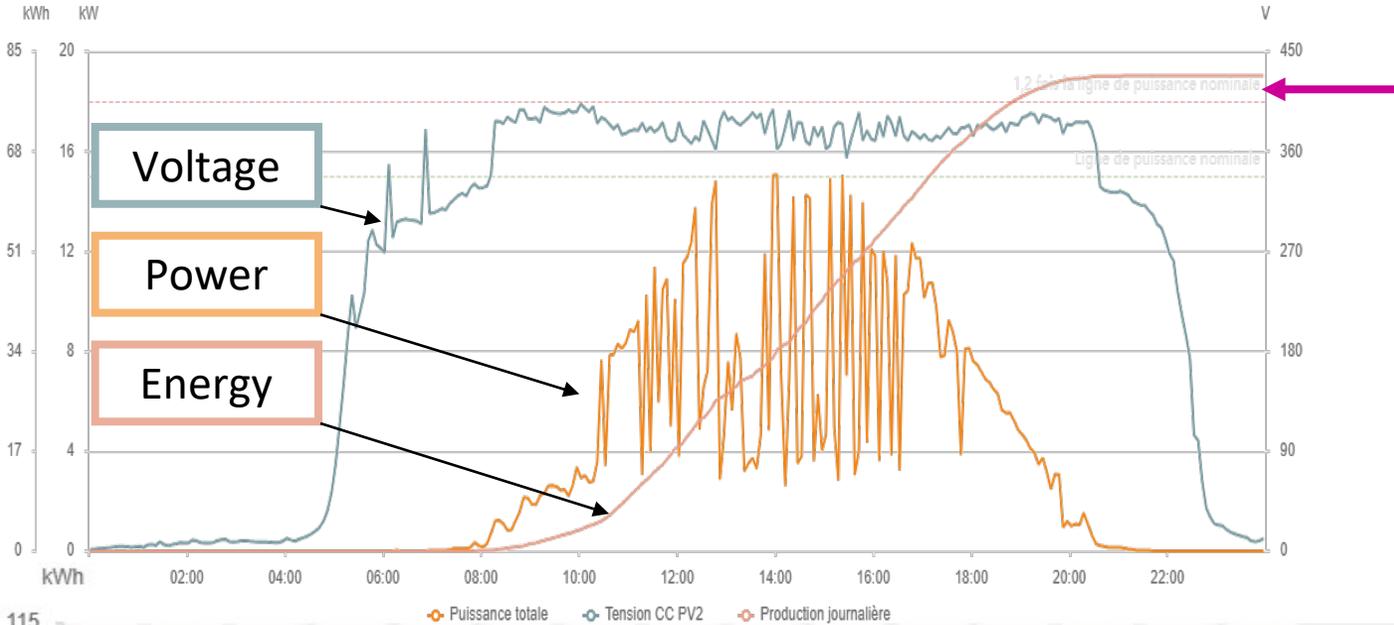
4MPPTs

Maximum Power Point Tracking

Extract the maximum possible power from PV panels



Real-time monitoring



Onduleur [Voir >](#)

Puissance: 1.728kW

Production journalière: 27.8kWh

Production totale: 5.521MWh

Réseau [Voir >](#)

Puissance totale injectée...: 0.048kW

Importation totale: 0kWh

Exportation totale: 27.83kWh

Batterie [Voir >](#)

Puissance de la batterie: --

Batterie SOH: --

Niveau de charge de la b...: --

État de charge de la batt...: --

Charge [Voir >](#)

Consumption Power: 1.782kW

Today Load Consumption: 28kWh

Total Load Consumption: 8.353MWh

CC	Tension	Courant	Puissance
PV1	383.1V	1.4A	536W
PV2	388.8V	1.3A	505W
PV3	404.2V	1.7A	687W
PV4	0V	0A	0W
MPPT1	383.1V	1.4A	536W
MPPT2	388.8V	1.3A	505W
MPPT3	404.2V	1.7A	687W

CA	Tension	Courant	F
L1	239V	2.3A	50.01Hz
L2	242V	3.4A	50.01Hz
L3	241.2V	1.7A	50.01Hz

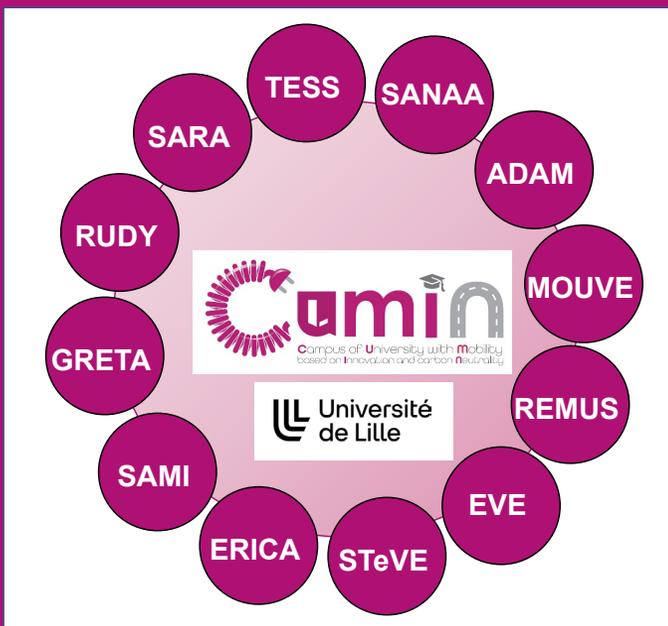
Plus >



system status



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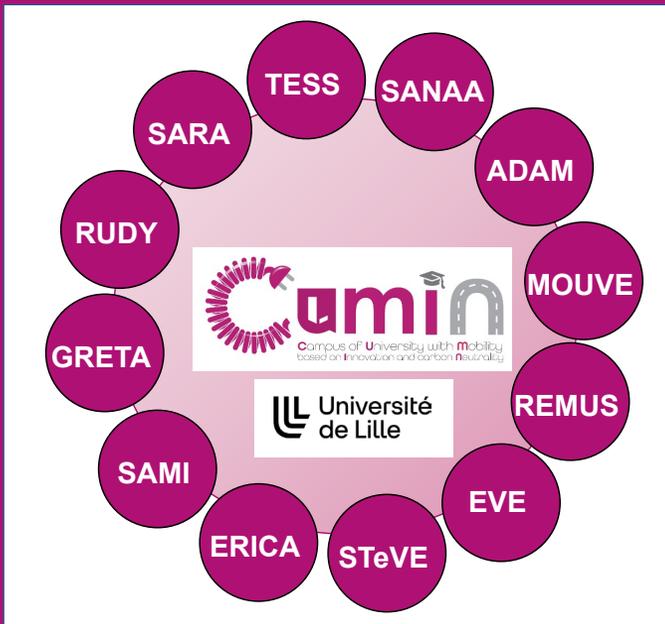
Conclusion

Conclusion

- ❖ The charging station does not support Vehicle-to-Grid (V2G).
It offers three modes: Fast, Eco, and Eco+ (G2V).
- ❖ The inverter can work in different scenarios to adapt to user needs.
It provides real time application, monitoring, and historical data.
- ❖ The installed system can fully charge the Electric Vehicle (EV) battery in the sunny days (100% solar for the Nissan Leaf).
- ❖ In winter or when there is no sun, solar production is lower. Charging is still possible, but:
charging power is reduced, or the grid is used as a complement to solar energy.
- ❖ Charging multiple EVs?



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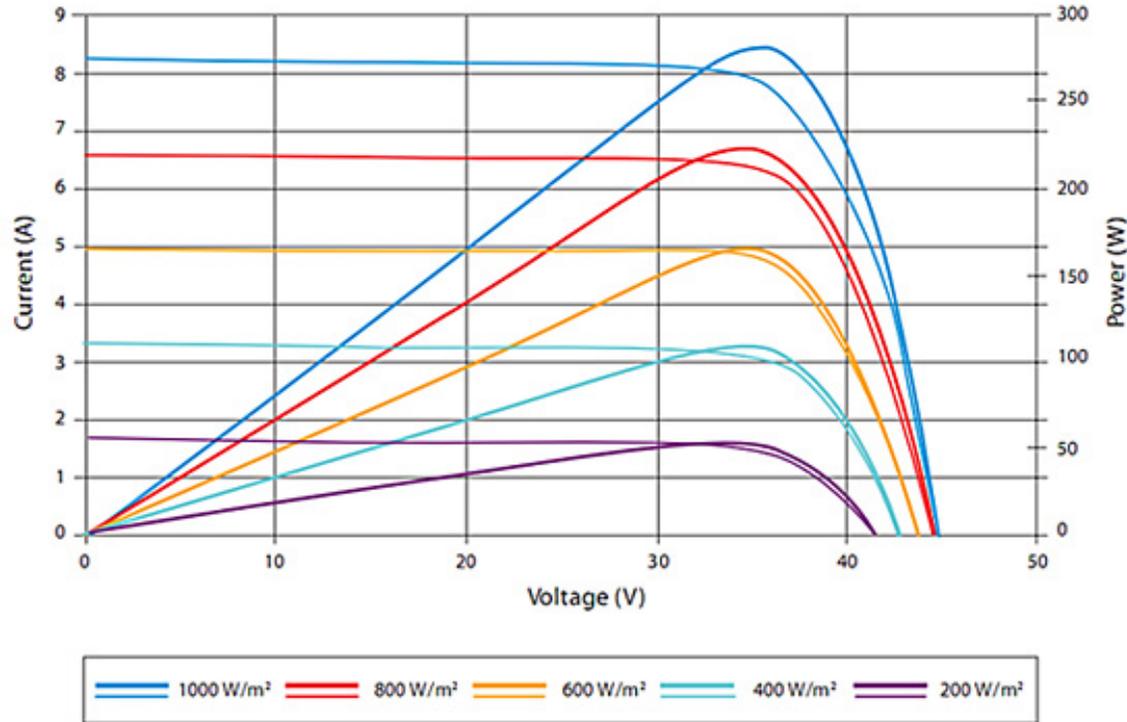


CUMIN programme

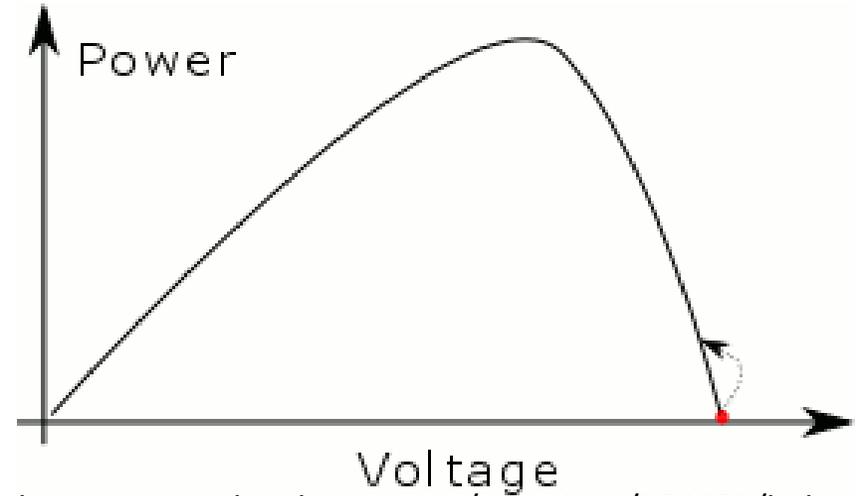
Our campus as
an exciting living lab
towards eco-cities!



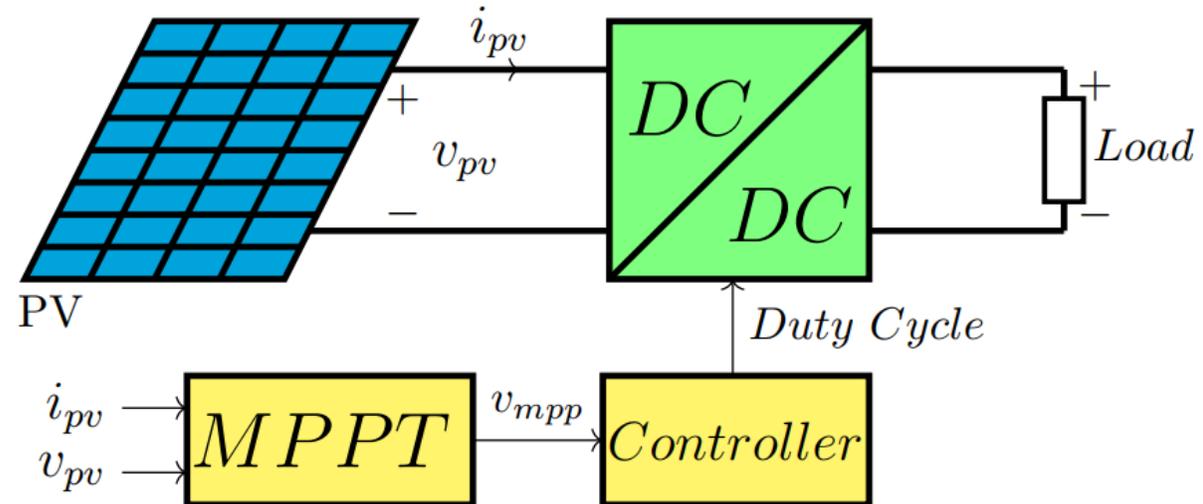
Maximum Power Point Tracking (MPPT)



<https://www.veichi.org/knowledge/what-is-mppt.html>



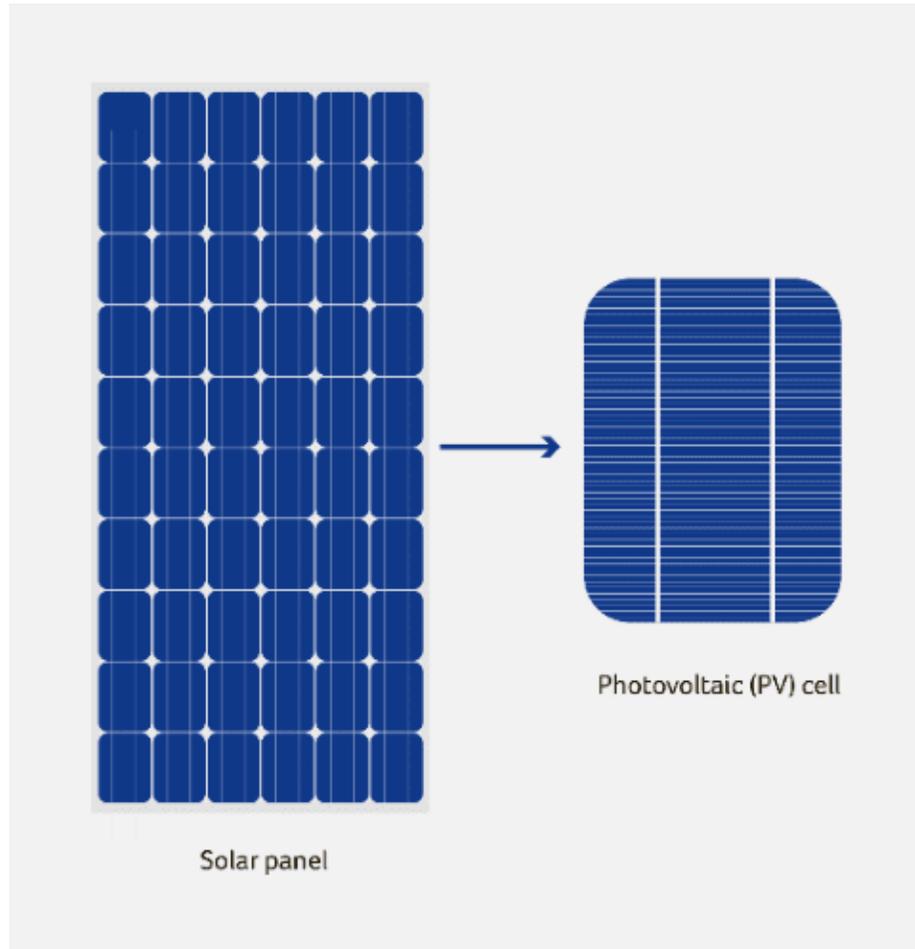
<https://electronics.stackexchange.com/questions/266863/help-on-mppt-algorithm>



<https://tikz.net/mppt/>

TOPCon technology

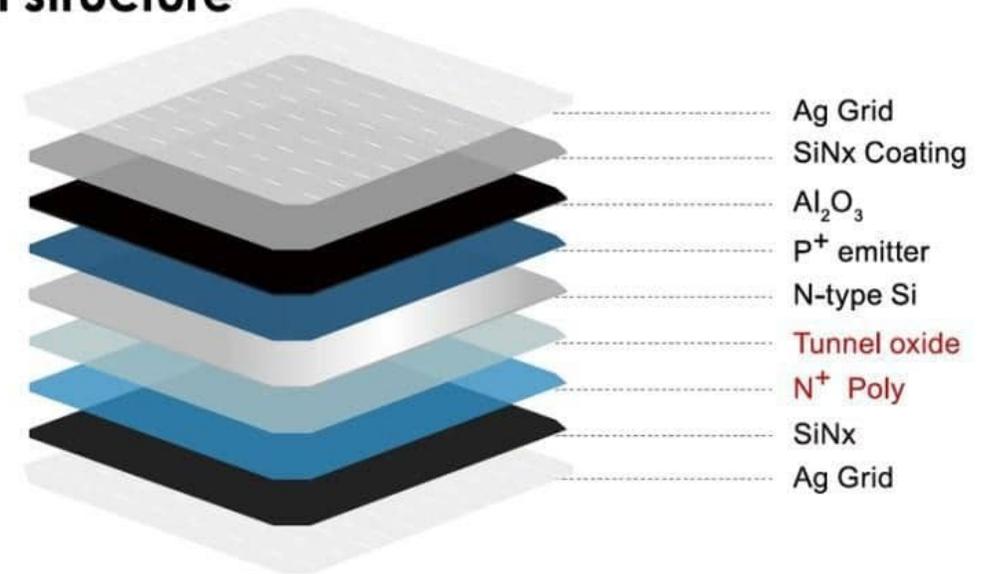
- An advanced crystalline silicon cell architecture that improve efficiency through better passivation and reduced losses.



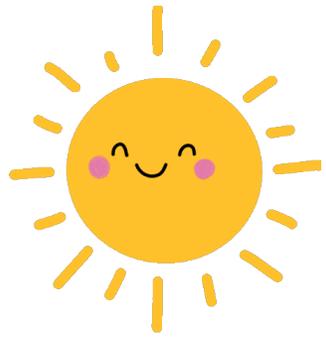
<https://www.solarconduits.com/the-ultimate-guide-to-solar-panels-from-basics-to-installation.html>

- TOPCon is achieved by adding an ultra-thin oxide layer and a doped silicon contact, allowing charge carriers to tunnel while suppressing recombination losses.

TOPCon cell structure



<https://variatesolar.com/topcon-technology-variante-solar-countvarname/>

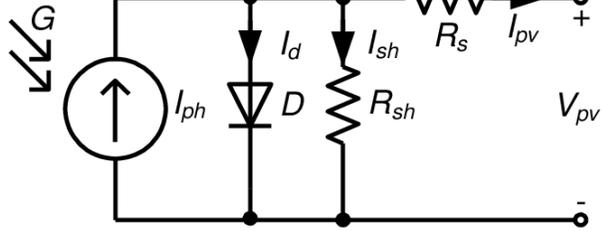




Modeling, Simulation and discussion.

System Modeling

- ❖ PV model
[Bellia et al. 14]



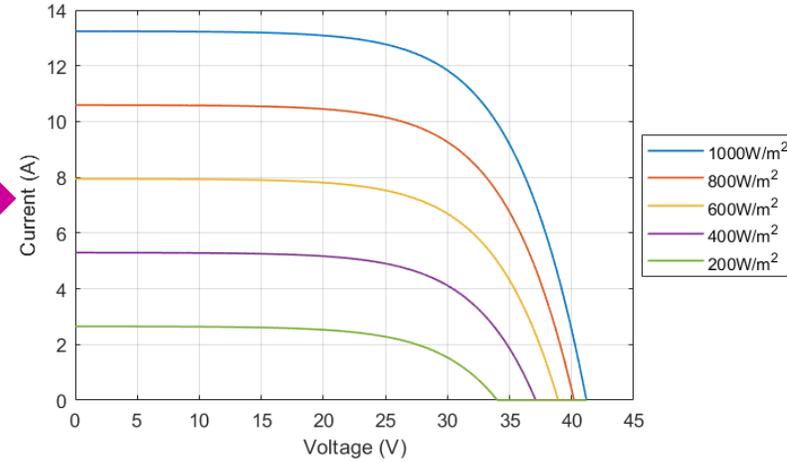
$$I_{PV} = I_{ph} - I_d - I_{sh}$$

$$I_d = I_o \left[\exp \left(\frac{V + I R_s}{a V_t} \right) - 1 \right]$$

$$I_{sh} = \frac{V + I R_s}{R_{sh}}$$

$$V_t = k \frac{T}{q}$$

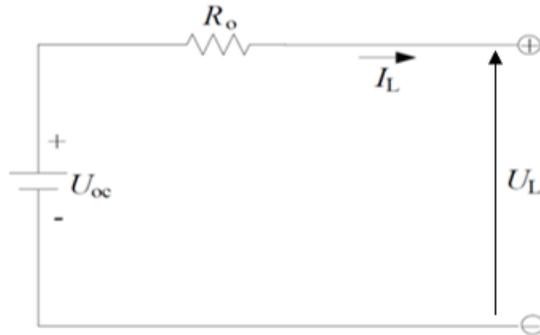
simulation
T = 25°C



$$I_{ph} = [I_{sc} + K_i(T - T_{ref})] \frac{G}{G_{ref}}$$

$$I_o = I_{oref} \left(\frac{T}{T_{ref}} \right)^3 \exp \left[\left(q \frac{E_g}{aK} \right) \left(\frac{1}{T_{ref}} - \frac{1}{T} \right) \right]$$

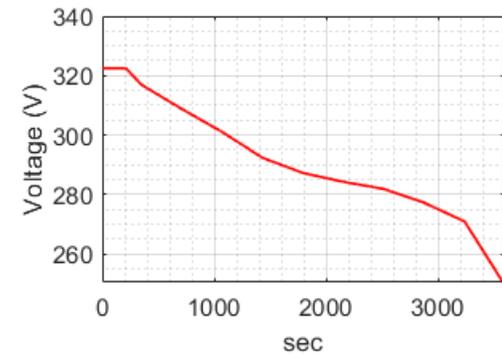
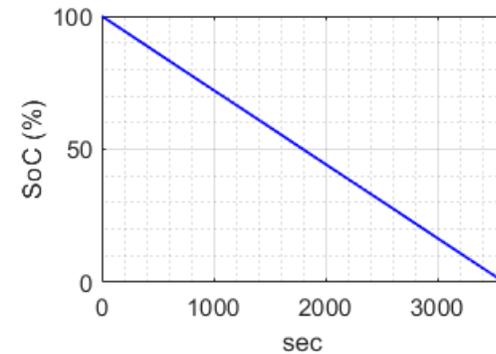
- ❖ Battery model [10]
- Initial SoC = 100%
- Capacity 35,7Ah



$$U_L = U_{oc} - R_o \cdot I_L$$

simulation

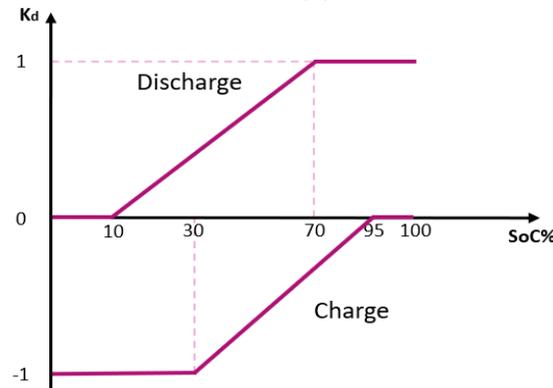
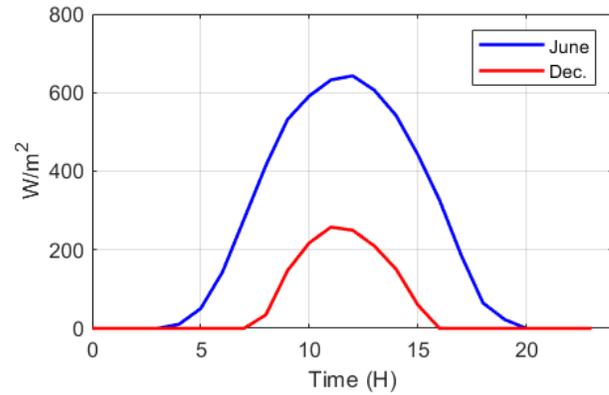
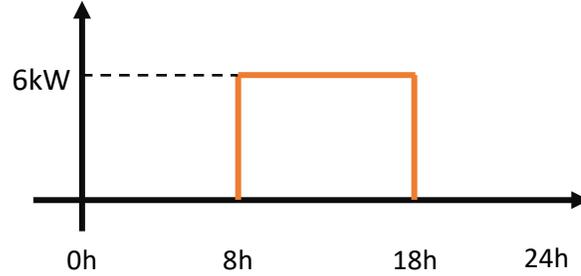
Scaled to 323V



U_{oc}, R_o : experimentally for a 4,2V lithium-ion battery.
(Dr. Alla Ndiaye)

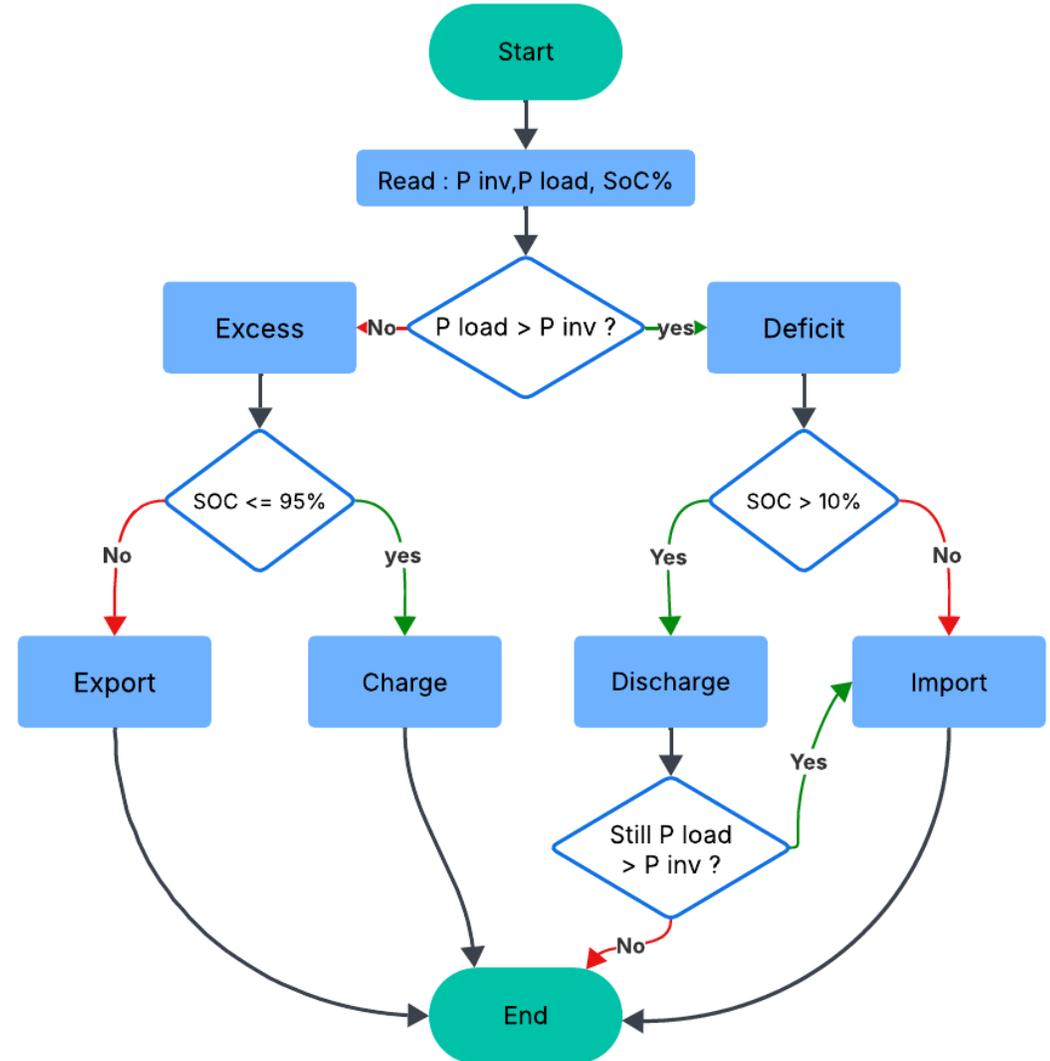
Modeling assumptions

- ❖ Load
 - EV initial SoC = 10%
 - EV total energy = 40kWh



Charge-discharge coefficient

- ❖ Battery management strategy
 - Current limitation at 30A

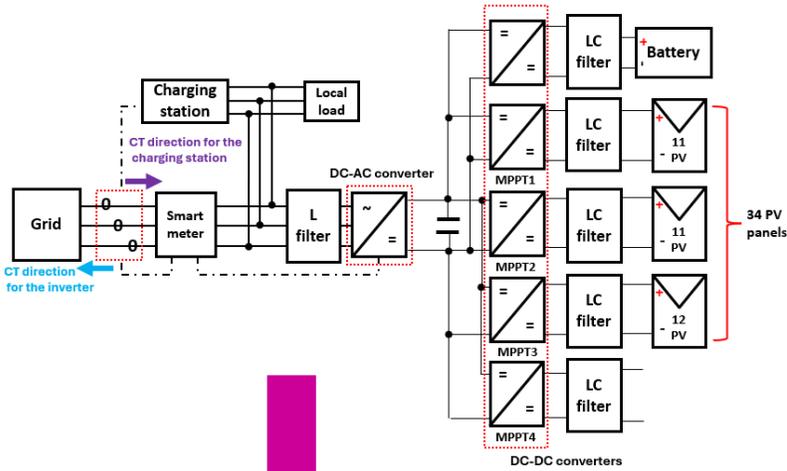


Charge-discharge Strategy

- ❖ Solar irradiation data
- ❖ Fixed temperature 25°C

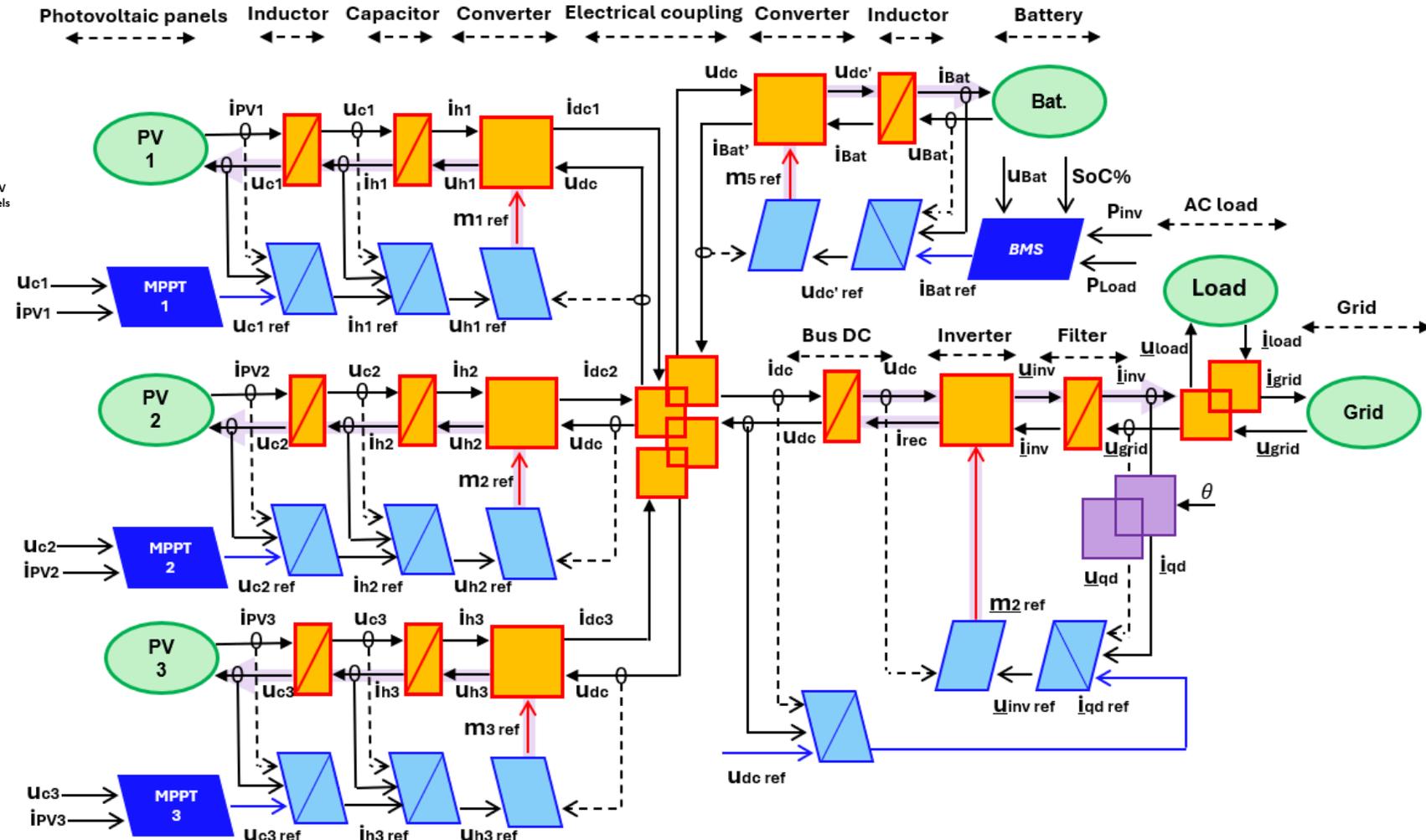
PHOTOVOLTAIC GEOGRAPHICAL INFORMATION SYSTEM
https://re.jrc.ec.europa.eu/pvg_tools

EMR of a grid connected PV system

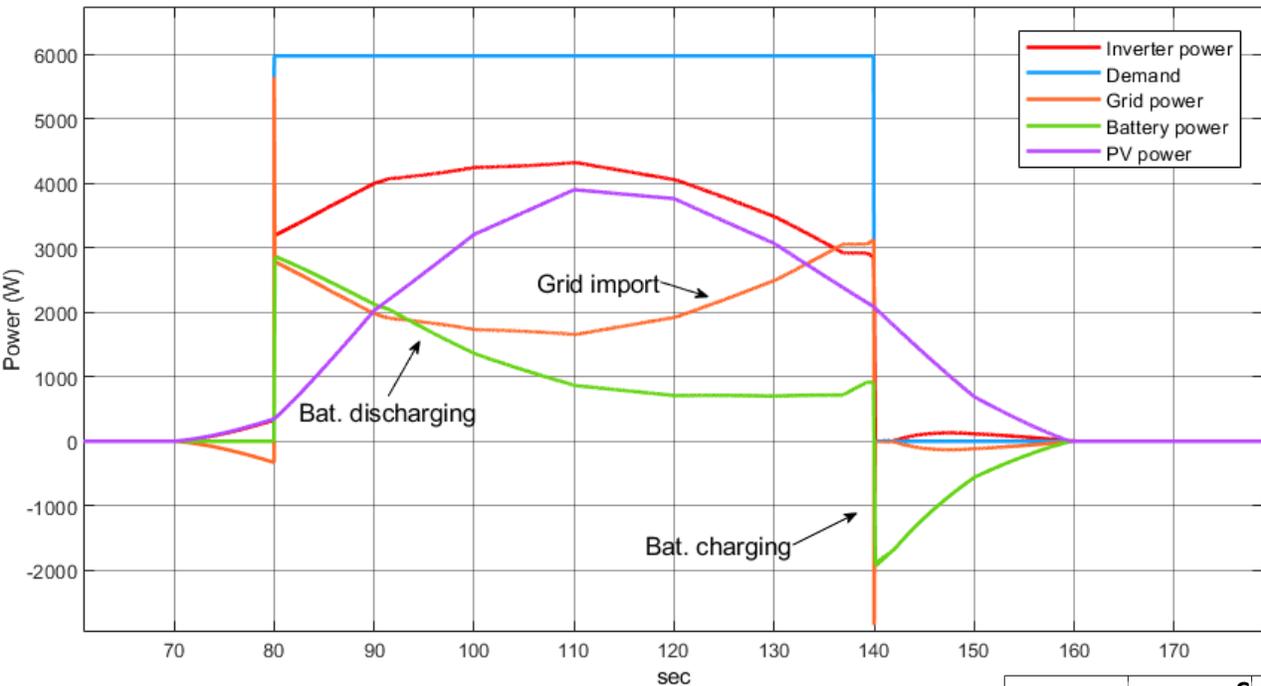


EMR & MSC

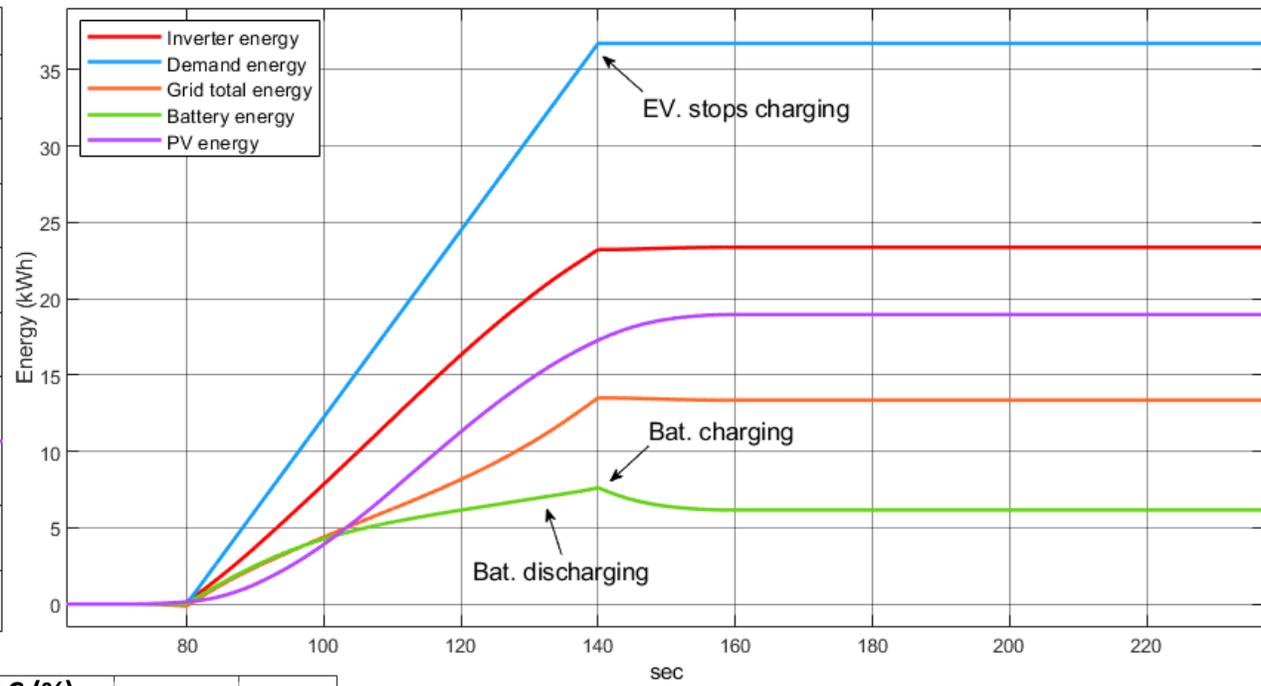
structural diagram of the studied system



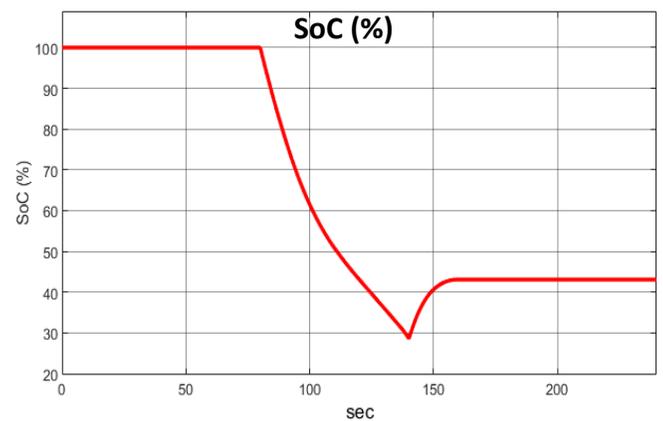
Results : December



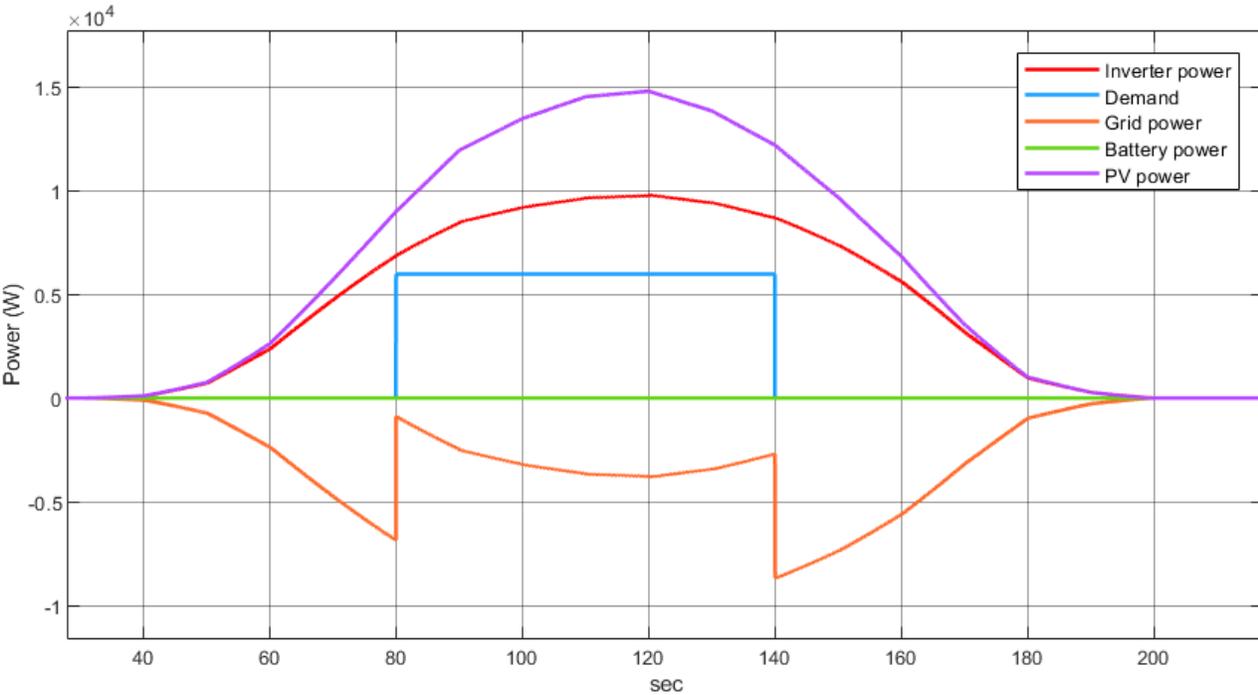
Output power of the different subsystems (W)



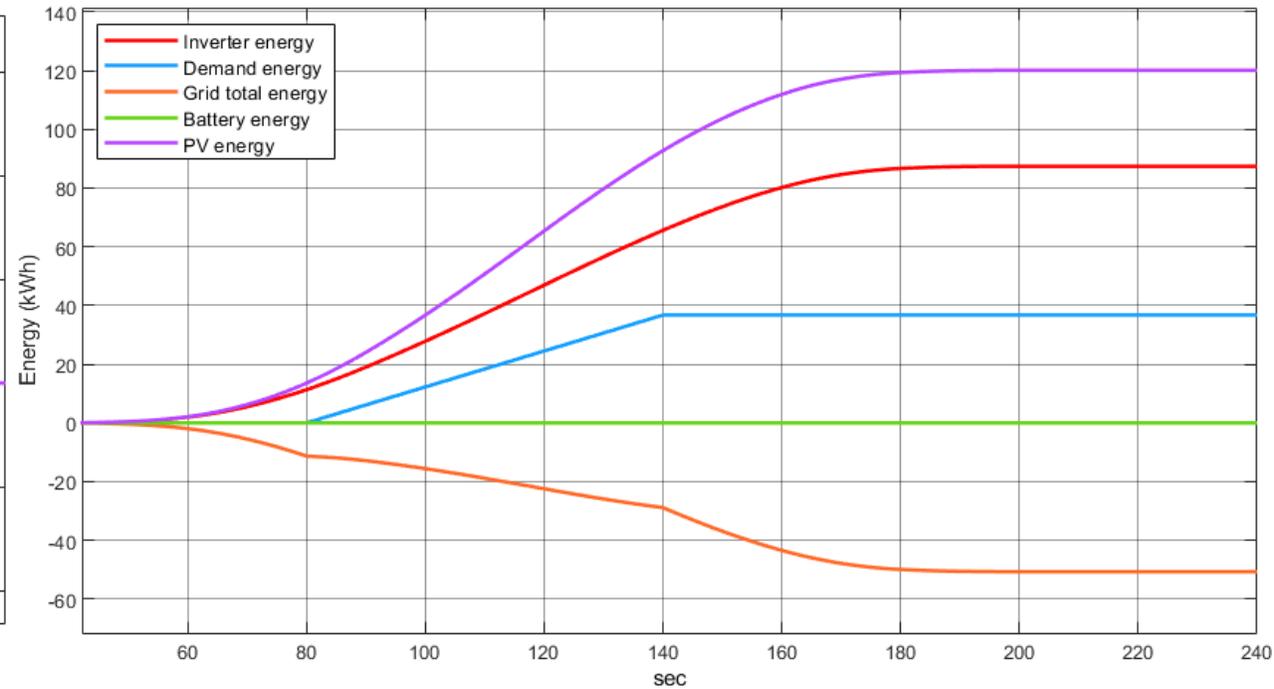
Accumulated energy (kWh)



Results : June



Output power of the different subsystems (W)



Accumulated energy (kWh)

References

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