Final Event
24-25th of May 2022

Evaluation Group

Powerful Advanced N-Level Digital Architecture
for models of electrified vehicles and their components

Fast charging station for EV

Cheng YE
Philippe FIANI
Philippe DELARUE

SHERPA ENGINEERING

In collaboration with

L2EP Laboratoire d'électrotechnique et d'électronique de puissance de Lille

Université de Lille

www.project-panda.eu

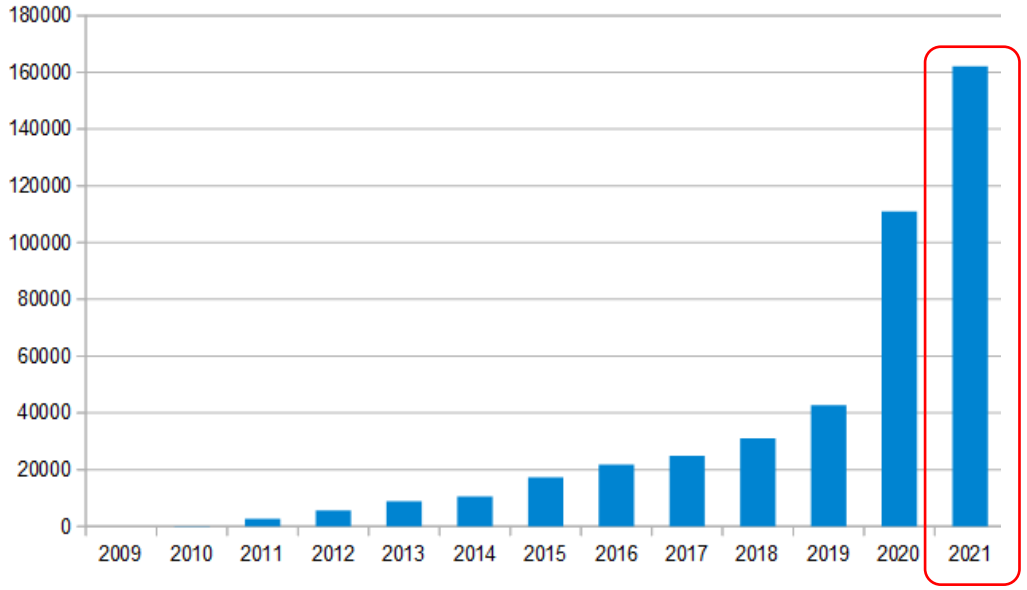
Content

1. Context & studied system
2. Modelling and control of the studied system
3. Simcenter AMESIM simulation
4. Feedback

1. Context & Studied system

Context

EVOLUTION OF THE NUMBER OF EVs SOLD IN FRANCE



(FICHES-AUTO,2022)

EVs → Charging stations

(EVBOX TRONIQ 50,2022)

Higher charging power

↓

Faster charging speed

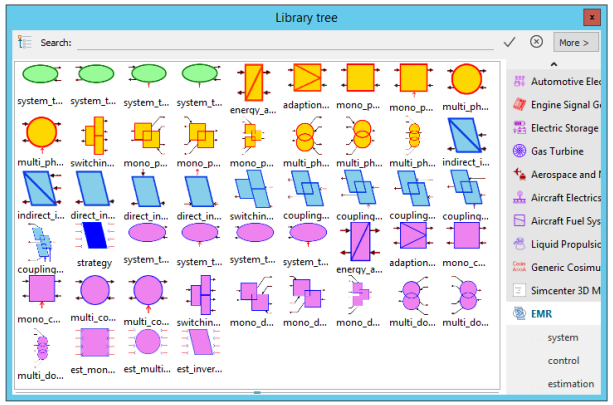
↓

Less charging time

Objective

- Implementation of the model of fast charging station on Simecenter-AMESIM ©

- By Sherpa engineering within the PANDA evaluation group

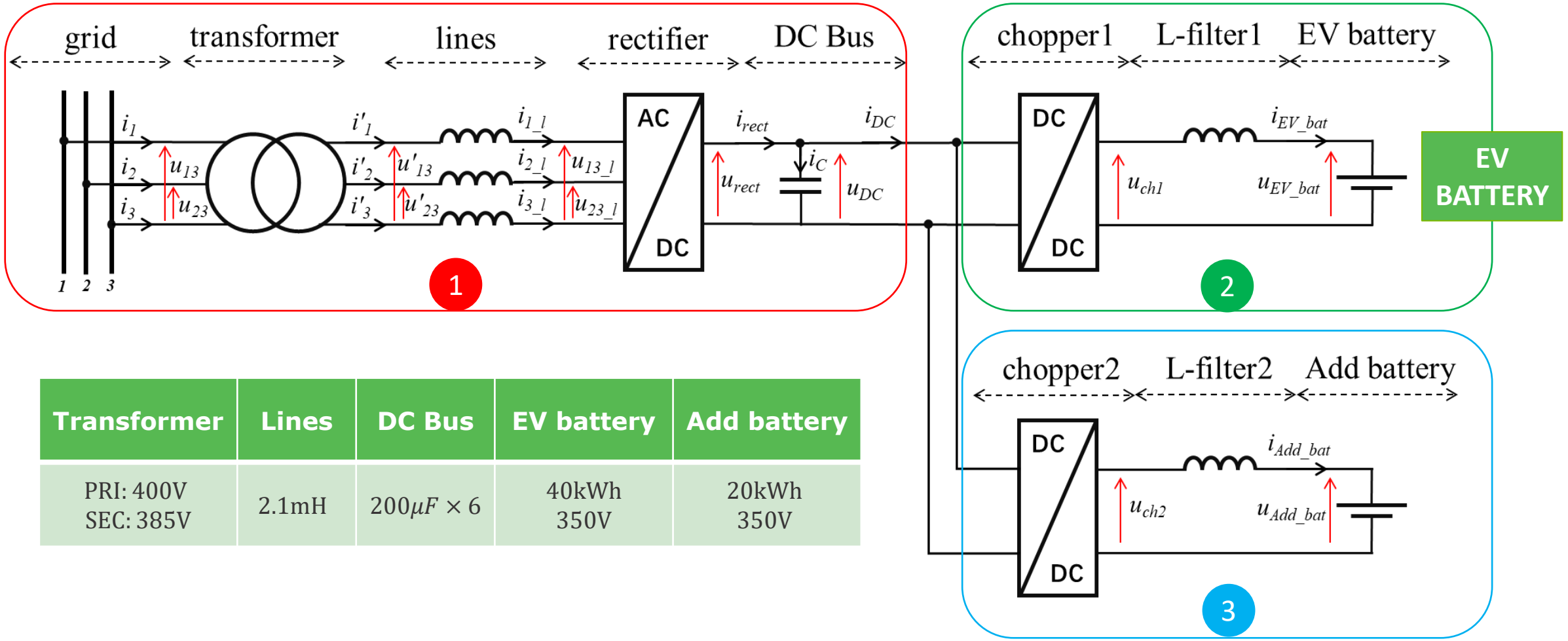


(EMR library in Simcenter-AMESIM)

- French company specializing in modeling, simulation and control design
- Rich experience in the automotive, aerospace and energy fields

In collaboration with

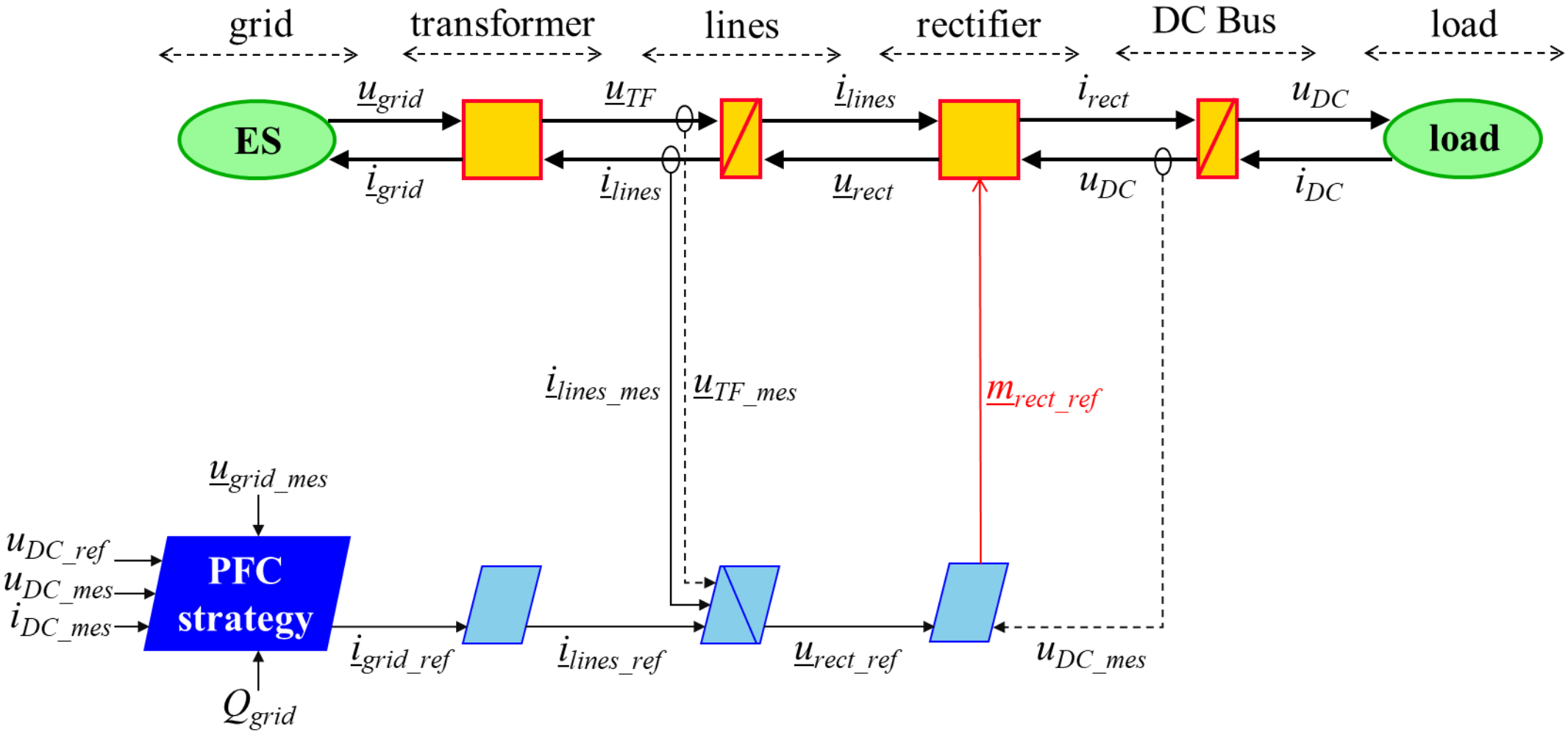
Studied system (EVBOX TRONIQ 50,2022)



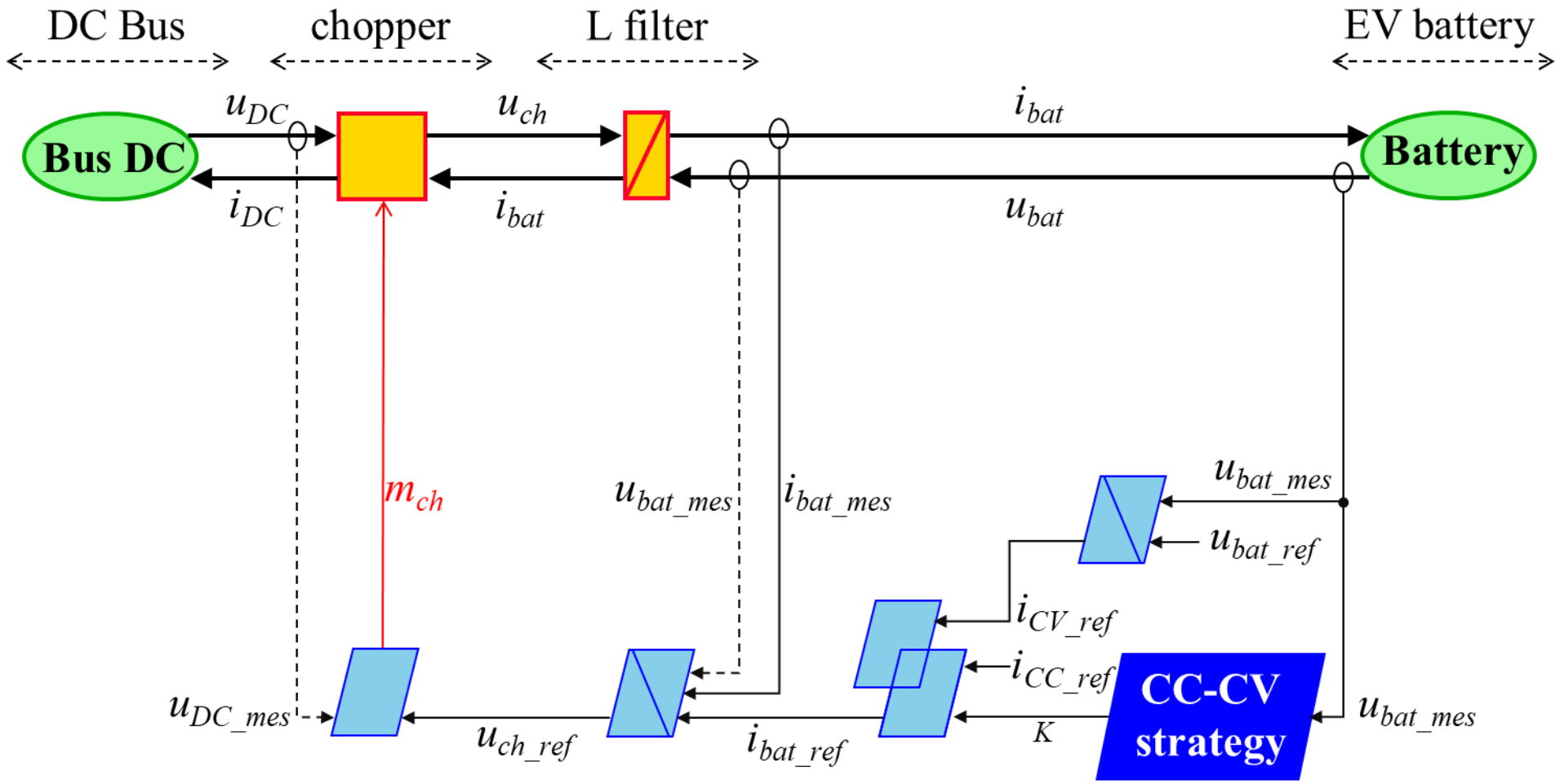
Transformer	Lines	DC Bus	EV battery	Add battery
PRI: 400V SEC: 385V	2.1mH	$200\mu F \times 6$	40kWh 350V	20kWh 350V

2. EMR & control of the studied system

EMR and control of the supply subsystem



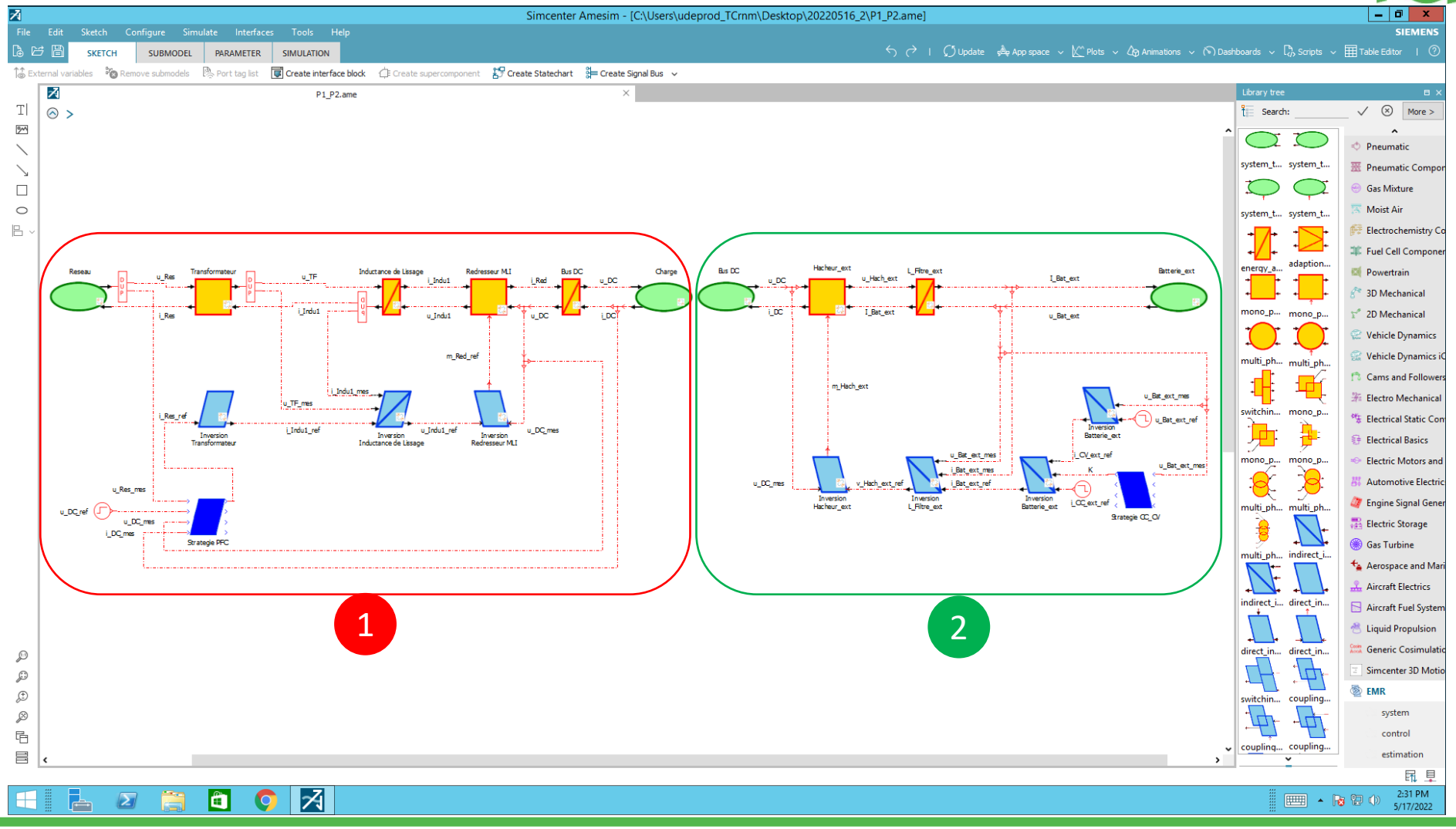
EMR and control of the charging subsystem



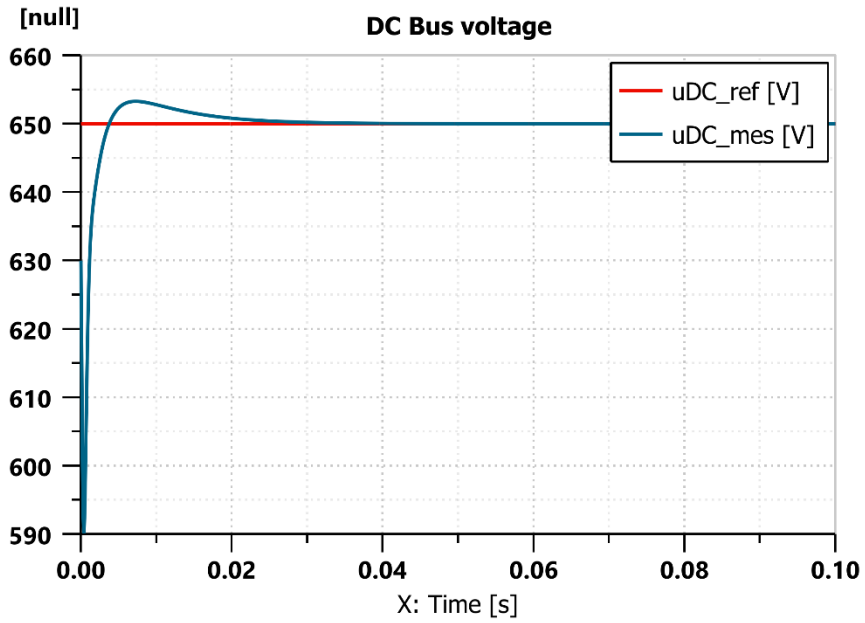
3. Simcenter-AMESIM simulation

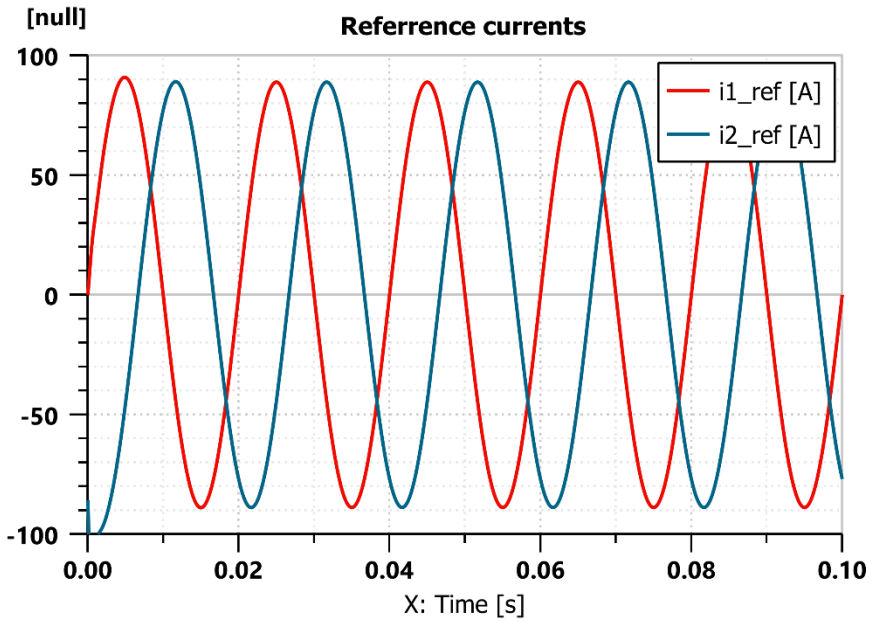
Simcenter-AMESIM model

Only cloud computing



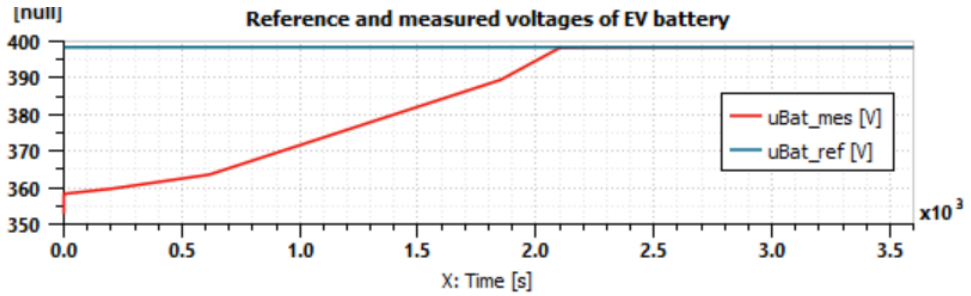
Simulation results of the grid connection

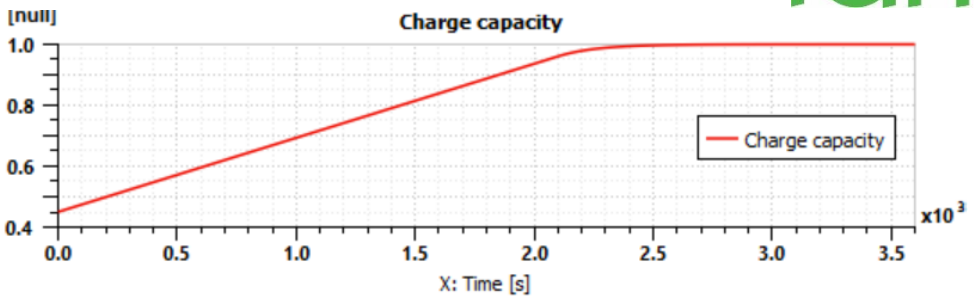


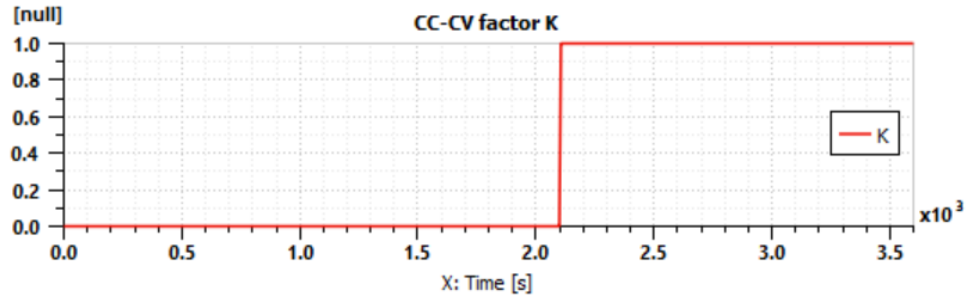


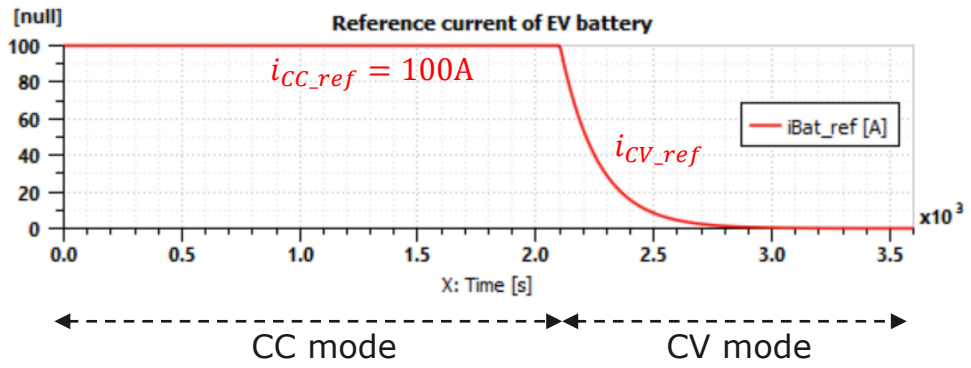
- We obtain a constant voltage (650V) outputted by DC Bus.
- Thanks to PFC strategy, we find out the reference currents of grid, which are sinusoidal.

Simulation results of the EV charging





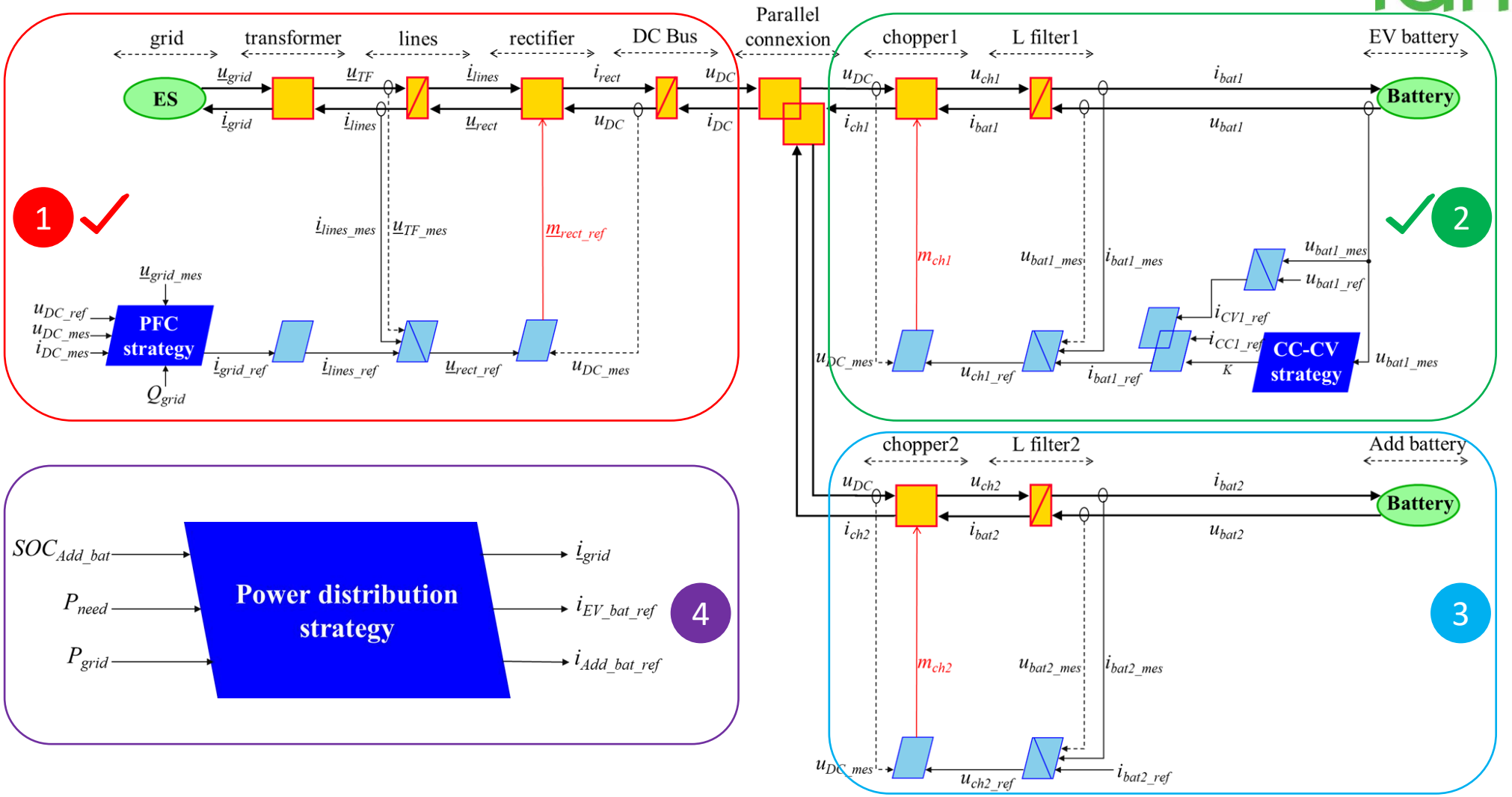




CC mode (0s -> 2100s)	CV mode (2100s ->3600s)
u_{bat_mes} rise	u_{bat_mes} constant
K = 0	K = 1
i_{bat_ref} constant	i_{bat_ref} reduce
Charge capacity : 0.45 -> 1	

4. Next steps & Feedback

Next steps


grid
transformer
lines
rectifier
DC Bus
Parallel connexion
chopper1
L filter1
EV battery
ES
Battery
1
2
PFC strategy
CC-CV strategy
chopper2
L filter2
Add battery
3
4
Power distribution strategy

Feedbacks

- The studied systems was already implemented in MATLAB Simulink ©
- EMR is already taught in Master degree (no need of training)
- Time to understand Simecenter AMESIM ©: 3 weeks
- Interest of the EMR library: fast transposition from MATLAB Simulink
- Interest of the cloud: some difficulty to start session
- Interest of the PANDA method: unified way to connect many subsystems and control

Evaluation Group

SHERPA ENGINEERING

In collaboration with

L2EP Laboratoire d'électrotechnique et d'électronique de puissance de Lille

Université de Lille

End of presentation

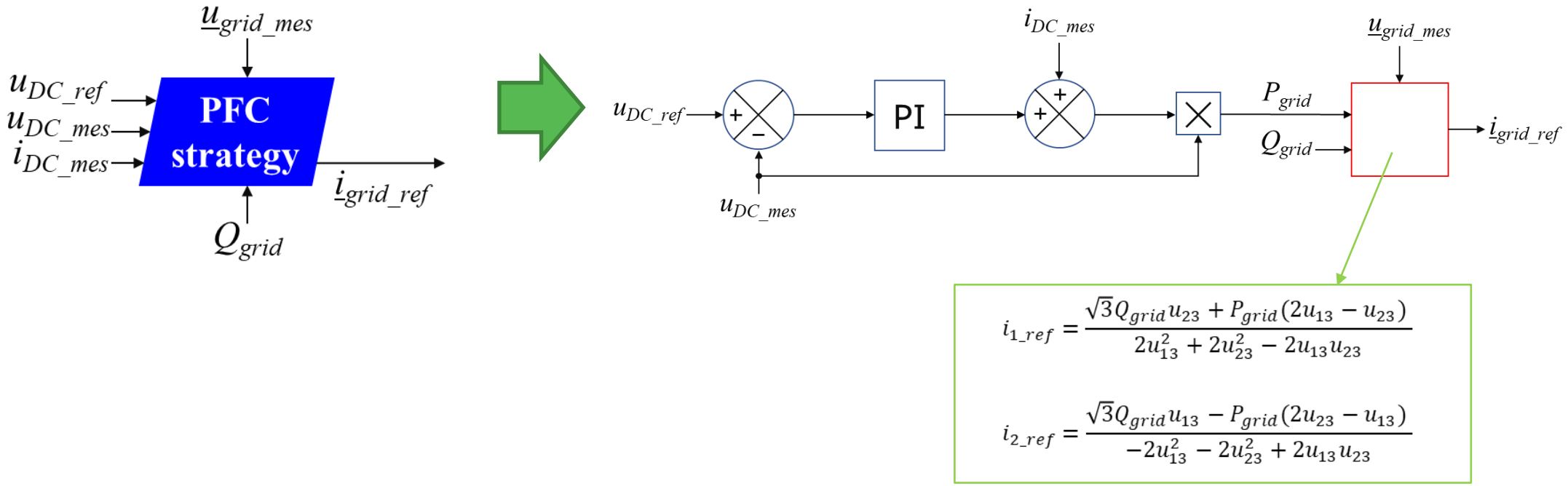
www.project-panda.eu

Université de Lille · SIEMENS · VUB VRIJE UNIVERSITEIT BRUSSEL · Valeo · UNIVERSITATEA TEHNICĂ · Typhoon HIL · TÜV SÜD · UBFC UNIVERSITÉ BOURGOGNE FRANCHE-COMTÉ · UNIRESEARCH · Renault Group · BLUWAYS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824256.

Appendix - PFC strategy [Bouscayrol 2005]

- **Power Factor Control (PFC)** : translate the grid voltages $\underline{u}_{grid}$, the active power P_{grid} and the reactive power Q_{grid} into the reference currents of grid i_{1_ref} and i_{2_ref}.

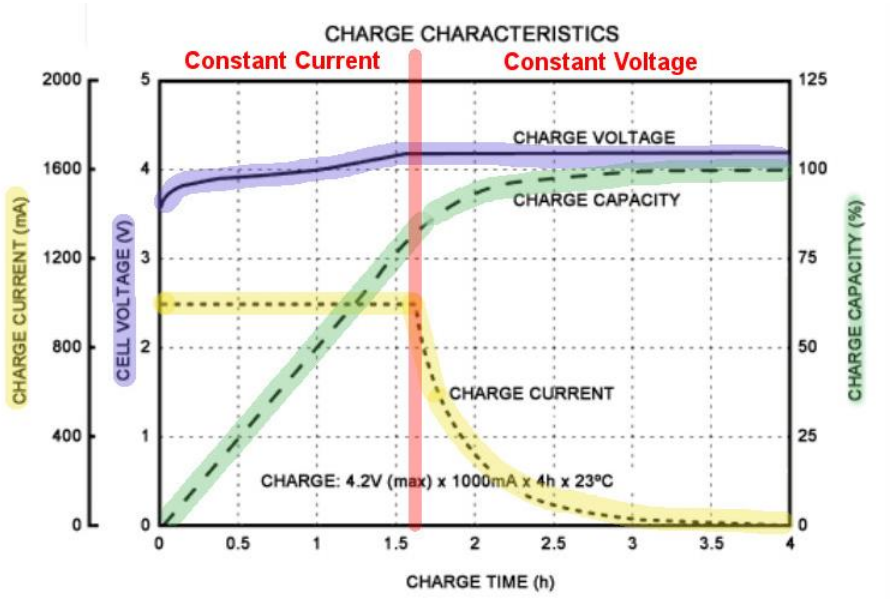


$$i_{1\_ref} = \frac{\sqrt{3}Q_{grid}u_{23} + P_{grid}(2u_{13} - u_{23})}{2u_{13}^2 + 2u_{23}^2 - 2u_{13}u_{23}}$$

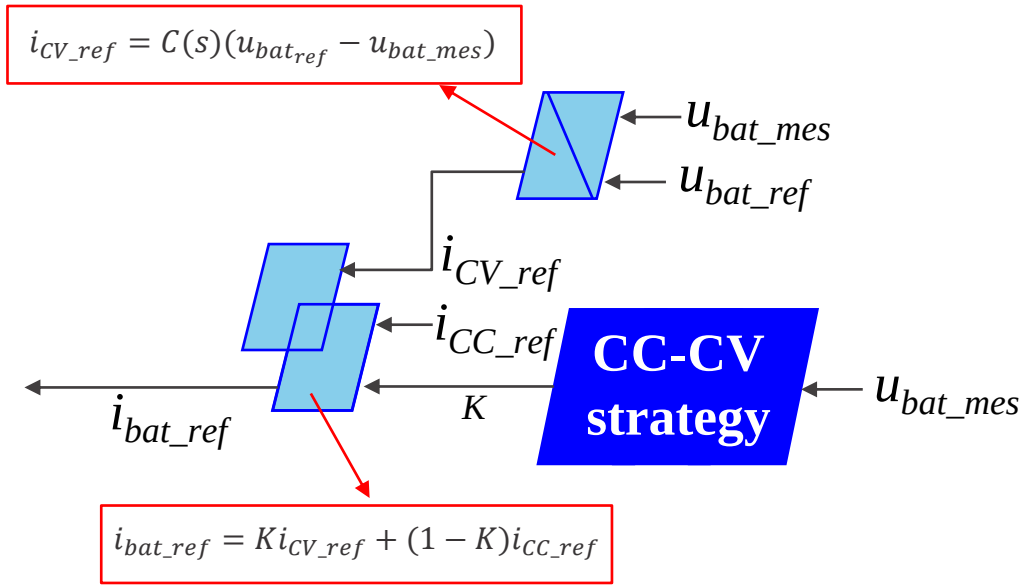
$$i_{2\_ref} = \frac{\sqrt{3}Q_{grid}u_{13} - P_{grid}(2u_{23} - u_{13})}{-2u_{13}^2 - 2u_{23}^2 + 2u_{13}u_{23}}$$

Appendix - CC-CV strategy

- **Constant Current-Constant Voltage (CC-CV)** : charge the battery initially at Constant Current, when its voltage reaches the Constant Voltage setting of charger, reduce the current exponentially until zero.



(Graphical explanation of CC-CV)



References

- FICHES-AUTO,2022 : https://www.fiches-auto.fr/articles-auto/l-auto-en-chiffres/s-1941-evolution-du-nombre-de-voitures-electriques-vendues-en-france.php
- EVBOX TRONIQ 50,2022 : https://www.evplug.fr/produit/evbox-troniq-50/
- BAZ 20 : Rapport de stage SHERPA 2020
- Graphical explanation of CC-CV : https://electronics.stackexchange.com/questions/509555/can-we-do-better-than-cccv-charging
- [Bouscayrol 2005] : A. Bouscayrol, P. Delarue, B. François, J. Niiranen, "Control implementation of a five-leg AC-AC converter to supply a three-phase induction machine", IEEE Transactions on Power Electronics, vol. 20, no. 1, pp. 107-115, January 2005
- [R.German 2018] : R. German, P. Delarue, A. Bouscayrol, "Battery Pack Self-heating During the Charging Process", IEEE-ICIT'18, Lyon (France), February 2018