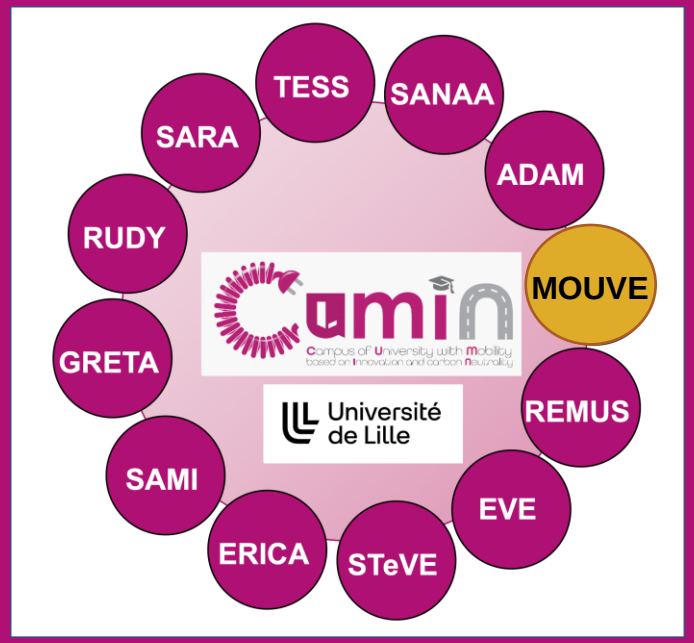
https://cumin.univ-lille.fr/



CUMIN - MOUVE

Université de Lille

Impact of Battery Thermal Conditioning on Electric Vehicle Charging time

Fairouz ABDUL-HAMID
Lauren BLE

Supervisor: Ronan GERMAN

Master VIE
Université de Lille

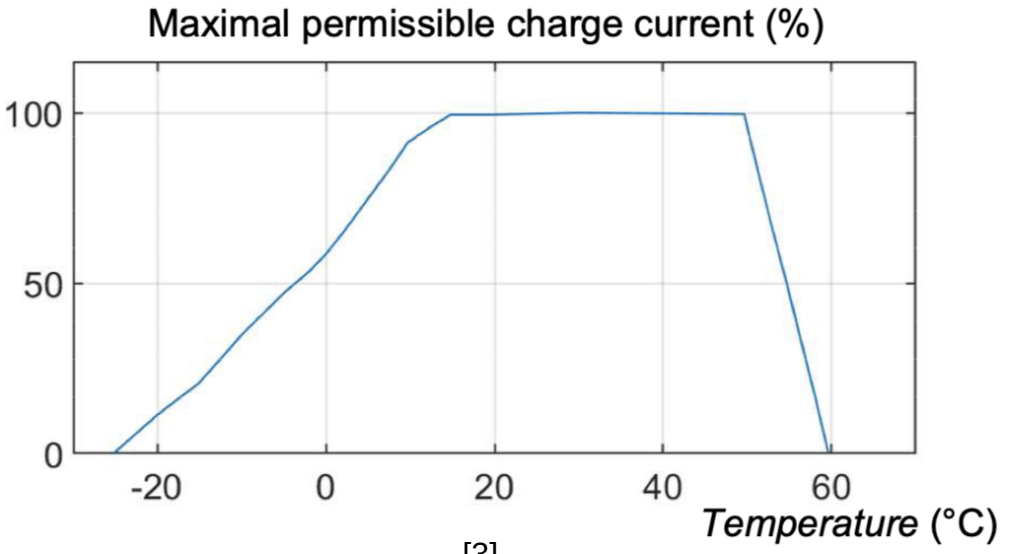
Context and Objective

- **Context:**
  - Battery charging current depends on temperature

→ Charging time increases

→ Thermal management becomes critical

- Cooling 
- Heating 



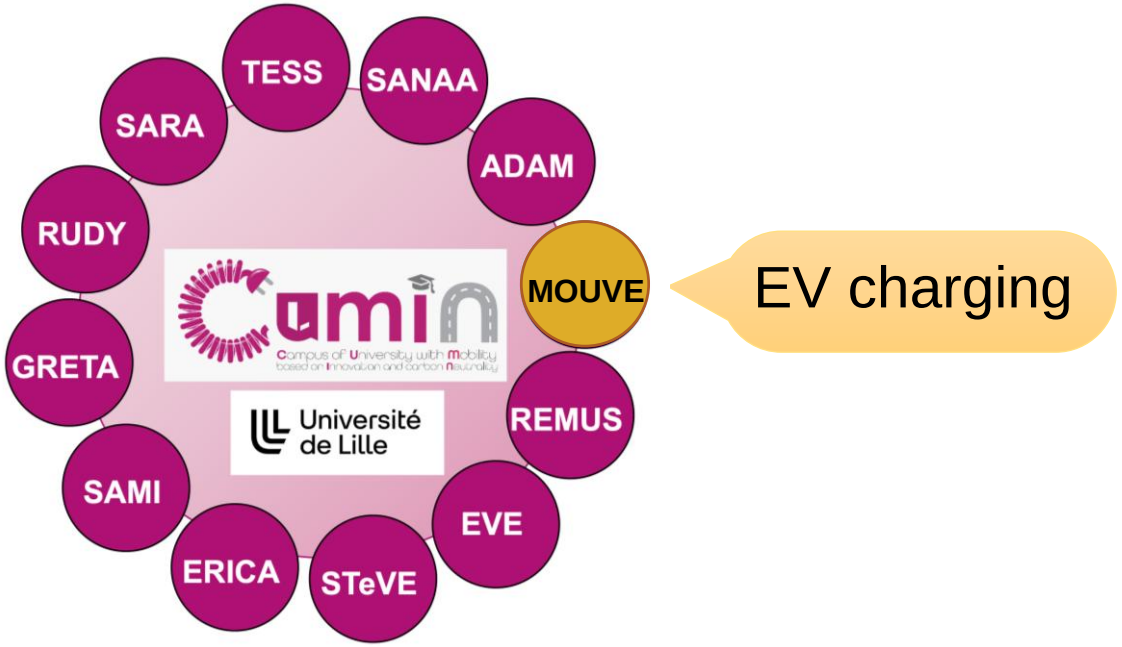
[3]

- **Objectif:** Study the impact of battery thermal conditioning on the electric vehicle charging process

Project positioning

This project is carried out within

Programm CUMIN



MOUVE : MObility and Use of electric VEhicles and charging infrastructure

IAL eCAMPUS

Université de Lille — UQTR Université du Québec à Trois-Rivières

Divided into four research axes

IAL: International Associated Laboratory
eCAMPUS: electro-mobility for CAMPus of Universities based on Sustainability

https://cumin.univ-lille.fr/

OUTLINE

Outline

1. Electro-thermal battery modeling
2. Use cases
3. Simulation Results
4. Conclusion and Perspectives

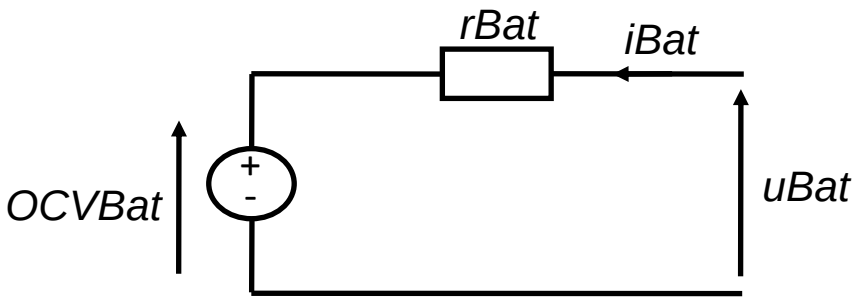
https://cumin.univ-lille.fr/

Electro-Thermal Battery Modeling

Electro-Thermal Modeling and EMR of a Battery

Structural schematic

Electrical Model

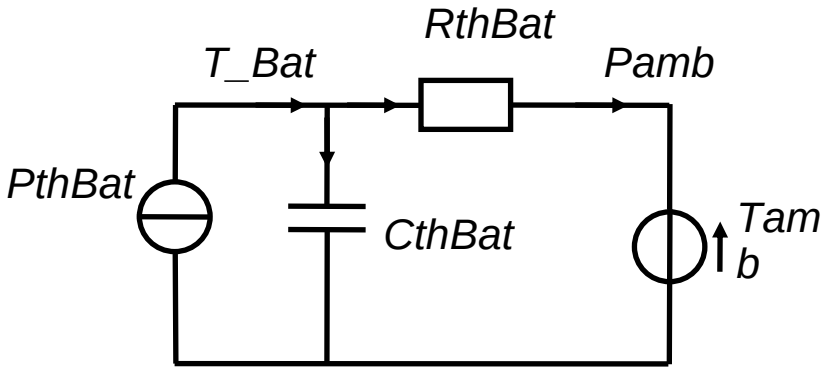


[3]

$PthBat = rBat \cdot iBat^2$

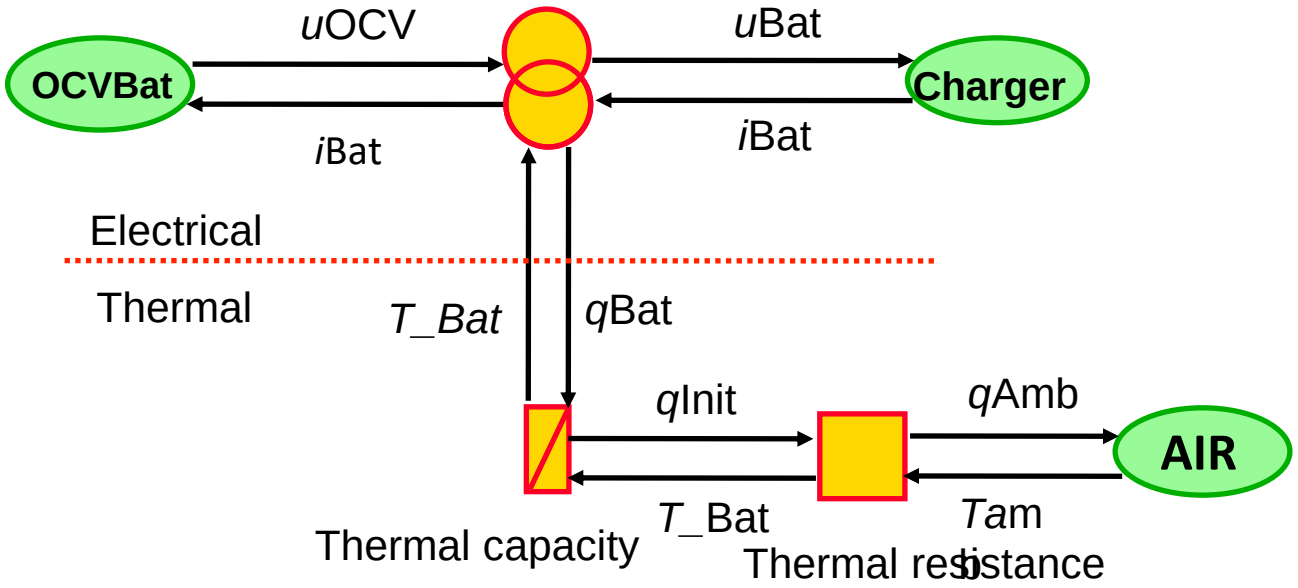
Joule Effect

Thermal Model



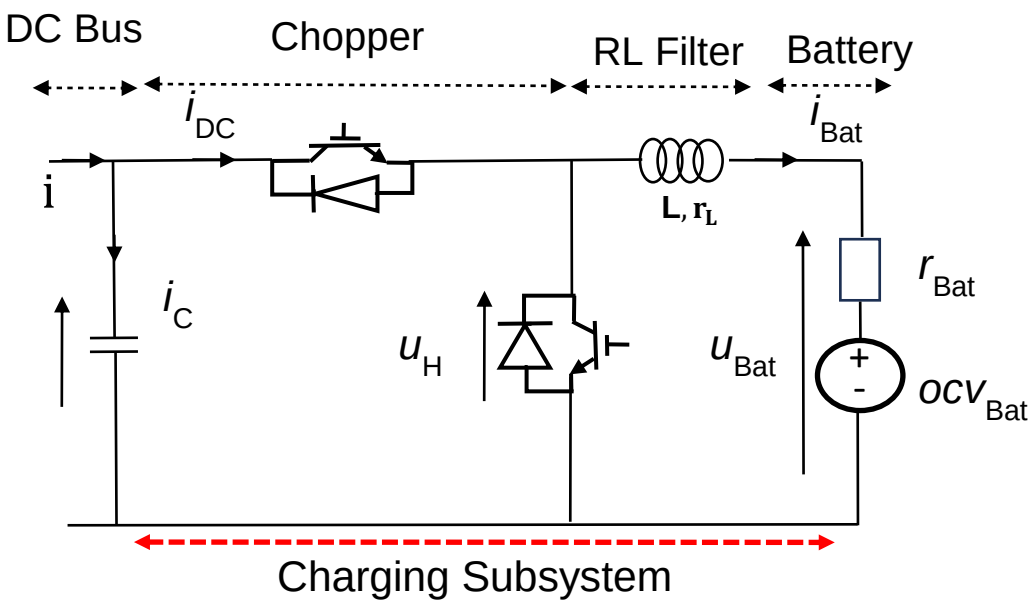
[3]

EMR of a battery

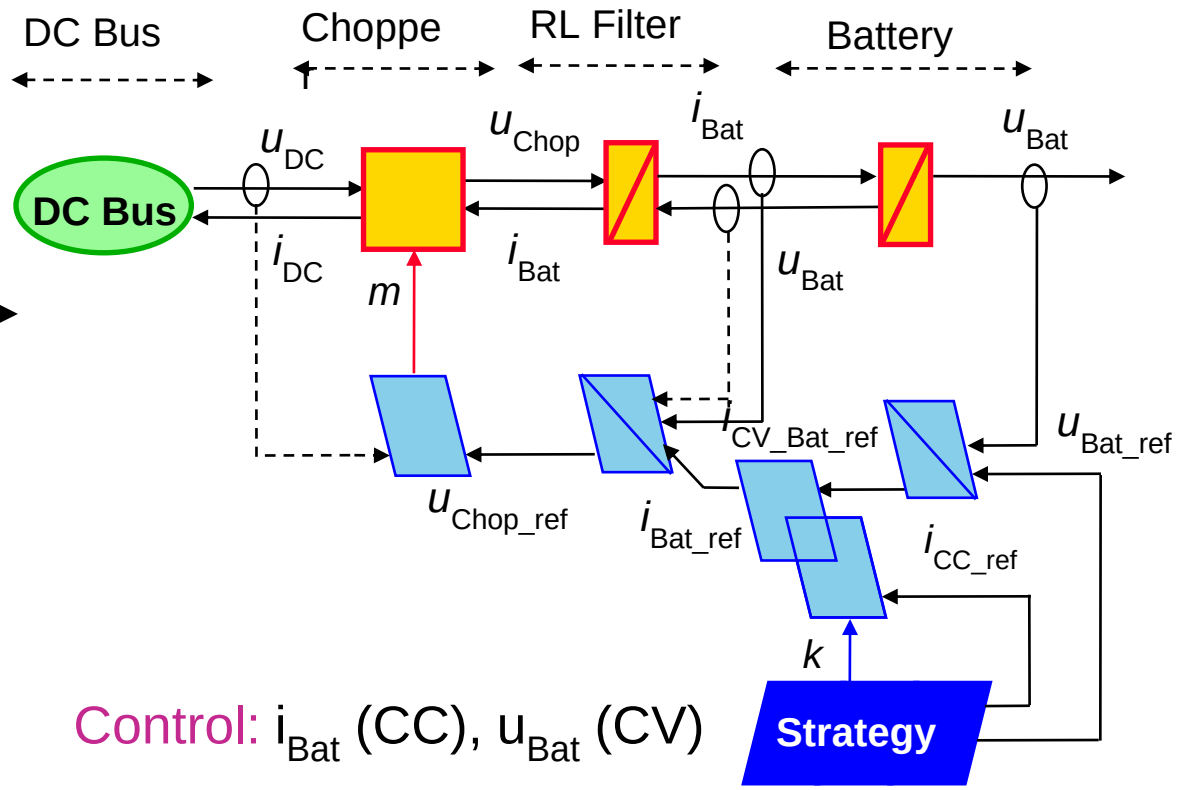


Charger Model and EMR with SMC

Structural schematic



EMR with SMC



Role of the Charger:

- The charger imposes the battery current iBat

Control: i_{Bat} (CC), u_{Bat} (CV)

Strategy:

- CC–CV charging strategy
- Charging current limitation based on battery temperature

https://cumin.univ-lille.fr/

Characterization of the current limitation

Characterization of the current limitation

Selected instrumented vehicle

Nissan Leaf battery pack

Electrical parameters

R_{Bat} = 167 mΩ

C_{Bat} = 108 Ah

U_{nom} = 360 V

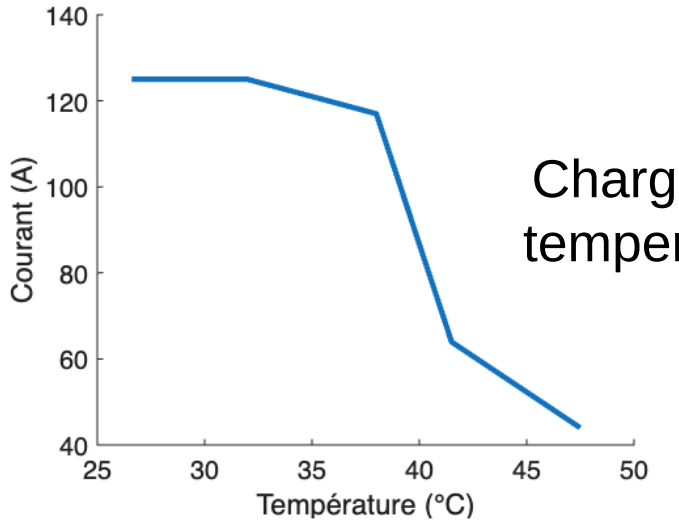
U_{max} = 402.39 V

Thermal parameters

C_{thBat} = 192 kJ/K

R_{thBat} = 0.169 K/W

Charging tests conducted at different battery temperatures



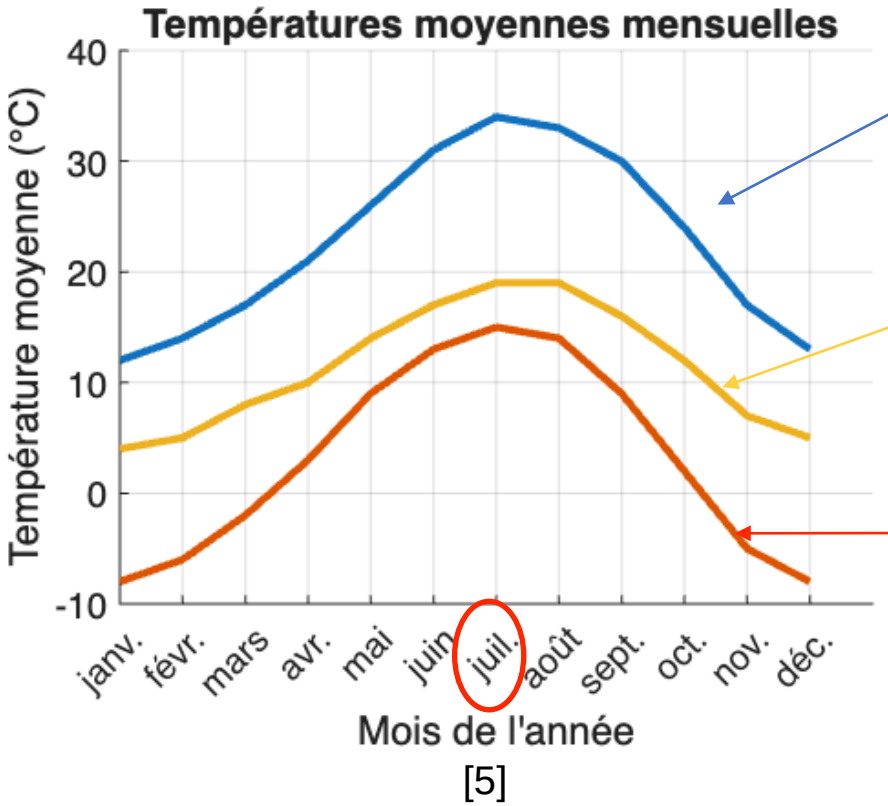
Charging current limitation with temperature for the Nissan Leaf

https://cumin.univ-lille.fr/

Use cases

Use cases

Three cities considered under summer conditions



[5]

- **Phoenix (Arizona, USA)**
  - → Hot climate
- **Lille (France)**
  - → Moderate climate
- **Anchorage (Alaska, USA)**
  - → Cold climate

Not regulated

Comparison with a battery perfectly regulated at 20 °C

The study is limited to warm-to-hot battery temperatures, for which charging data are available.

https://cumin.univ-lille.fr/

Simulation Results

Simulation Results

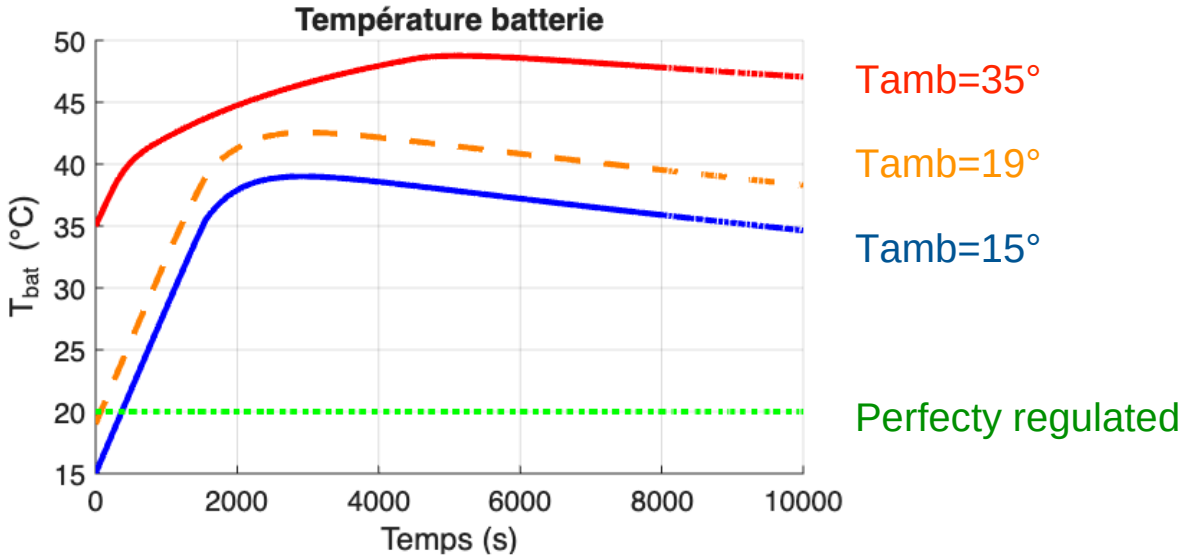
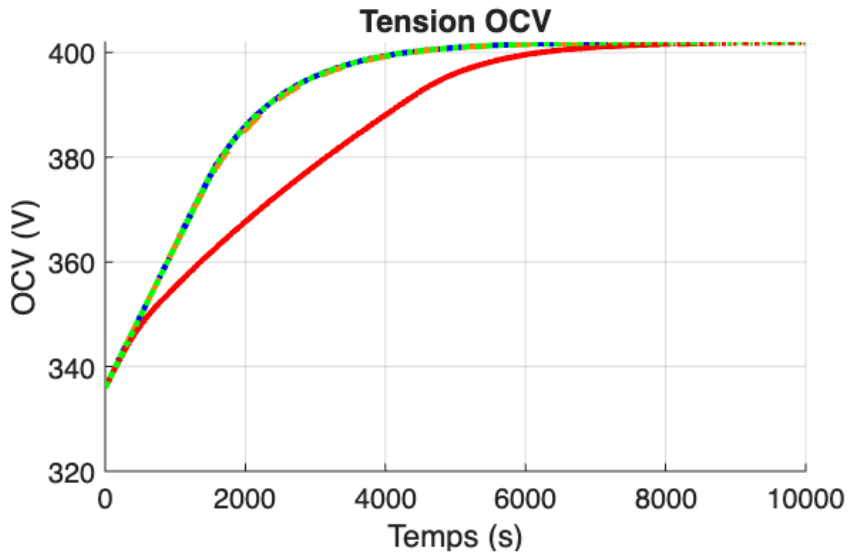


Fig.1:Influence of ambient temperature



Tamb ↑, OCV↓

Fig.3:Evolution of OCV

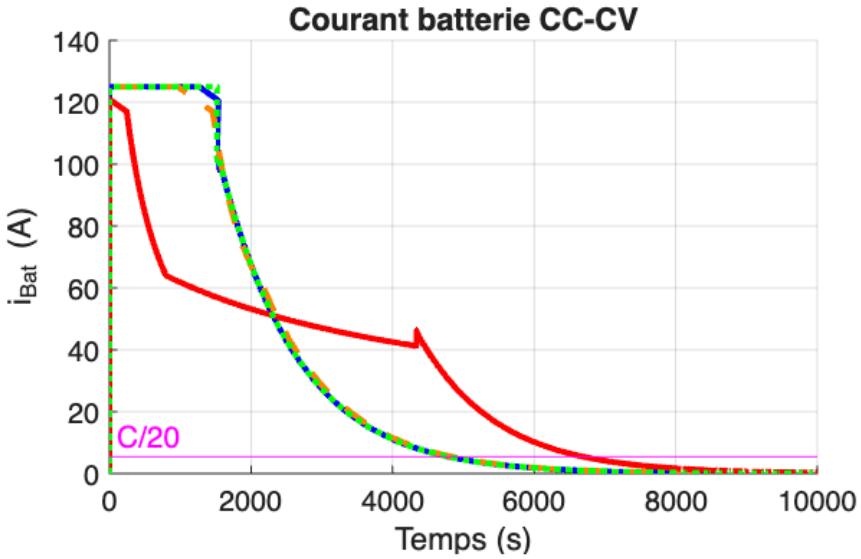
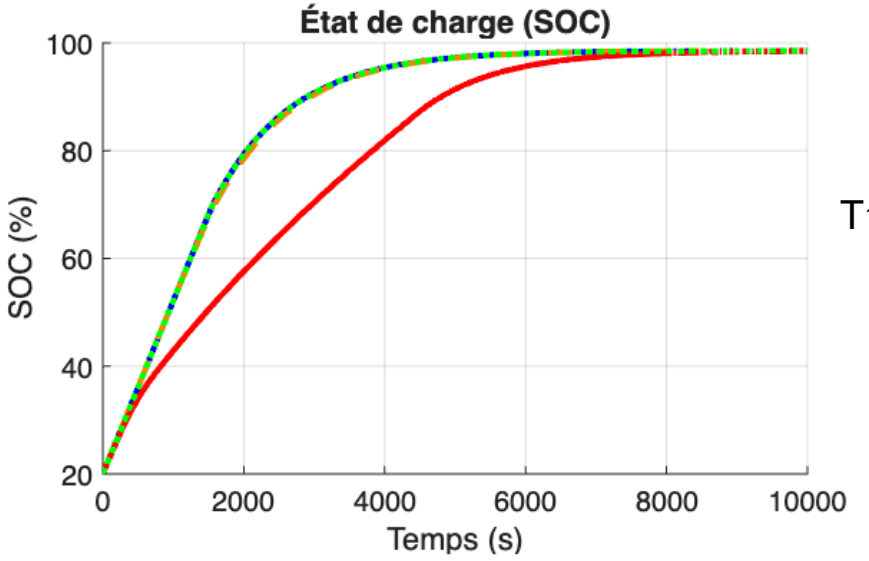


Fig.2:Battery current evolution during fast CC–CV charging



T↑ → t_charge↑

Fig.4:Evolution of SOC

https://cumin.univ-lille.fr/

Conclusion and Perspectives

Summary and Perspectives

Summary:

- Electro-thermal modeling of the battery
- Study of the impact of ambient temperature on charging
- Increase in battery temperature observed in all cases, with an amplitude depending on ambient conditions
- In hot conditions: faster temperature rise ⇒ **charging current limitation**
- Study of temperature impact in different cities.

Perspectives:

- Implementation of thermal conditioning (cooling)

Bibliography

[1]	« 2019 Nissan LEAF Review & Ratings », Edmunds. Consulté le: 26 janvier 2026. [En ligne]. Disponible sur: https://www.edmunds.com/nissan/leaf/2019/review/
[2]	L. Calearo, A. Thingvad, C. Ziras, et M. Marinelli, « A methodology to model and validate electro-thermal-aging dynamics of electric vehicle battery packs », Journal of Energy Storage, vol. 55, p. 105538, nov. 2022, doi: 10.1016/j.est.2022.105538.
[3]	S. R. Revankar, R. German, A. Groleau, A. Bouscayrol, L. Boulon, et E. Hittinger, « Impact of Battery Temperature on Charging Time of an Electric Vehicle for Slow Charging », in 2024 IEEE Vehicle Power and Propulsion Conference (VPPC), oct. 2024, p. 1-6. doi: 10.1109/VPPC63154.2024.10755231.
[4]	A. Ndiaye, R. German, A. Bouscayrol, M. Gaetani-Liseo, P. Venet, et E. Castex, « Impact of the User Charging Practice on the Battery Aging in an Electric Vehicle », IEEE Transactions on Vehicular Technology, vol. 73, no 4, p. 4578-4588, avr. 2024, doi: 10.1109/TVT.2024.3356116.
[5]	« Météo passée pour Lille 2025 (France) - Weather Spark ». Consulté le: 26 janvier 2026. [En ligne]. Disponible sur: https://fr.weatherspark.com/h/y/49799/2025/M%C3%A9t%C3%A9o-historique-en-2025-%C3%A0-Lille-France#Figures-Temperature