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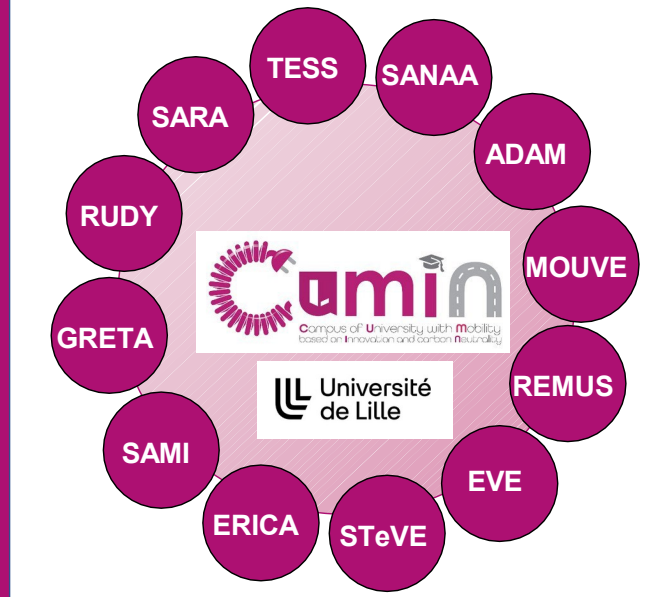

CUMIN - EVE

Energy consumption of an electric bus

Authors: ACHBAR Soumiya

BELKHIR Rayane

Supervisor: Pr Alain BOUSCAYROL

University of Lille
in collaboration with MEL

Outline

1. Context and objective
2. e-bus Simulation
3. Energy Consumption variations
4. Conclusion

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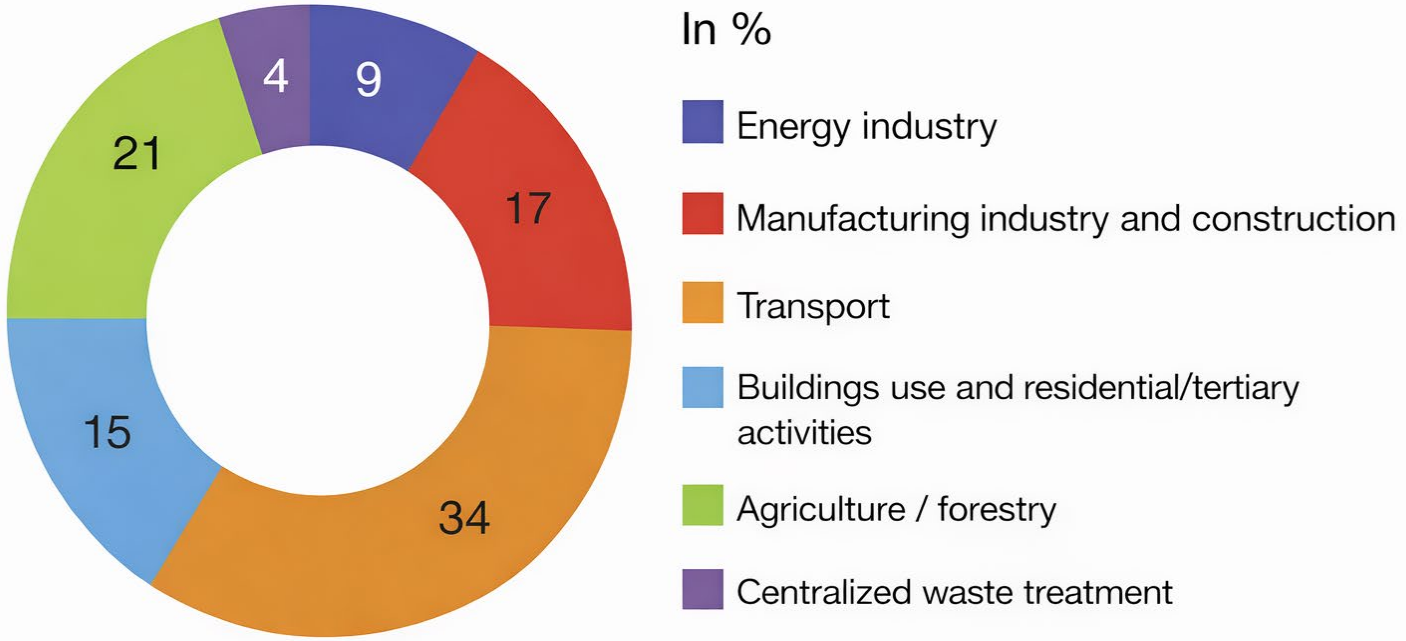
1. Context and objective

Context and objective



Sectoral distribution *of greenhouse gas emissions in France, 2024 (%).*

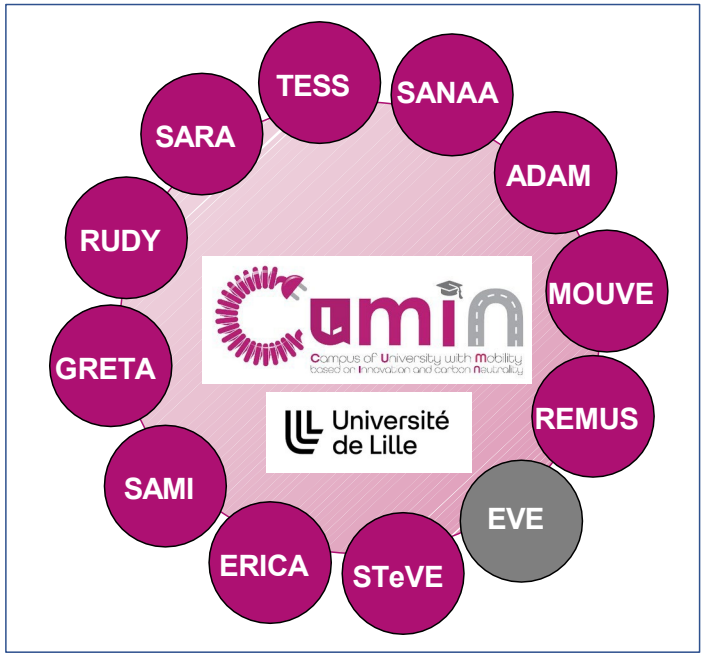
Note: 2024 data are preliminary estimates. **Source:** Format Secten – Citepa, 2025.

In Partnership With MEL MÉTROPOLE EUROPÉENNE DE LILLE

Context and objective

Positioning in the CUMIN programme

Campus of **U**niversity with **M**obility based on **I**nnovante and **C**arbon **N**eutrality



E-bus operate all day long

↓

Energy consumption is significant

↓

Impact of operating conditions?

MEL MÉTROPOLE EUROPÉENNE DE LILLE

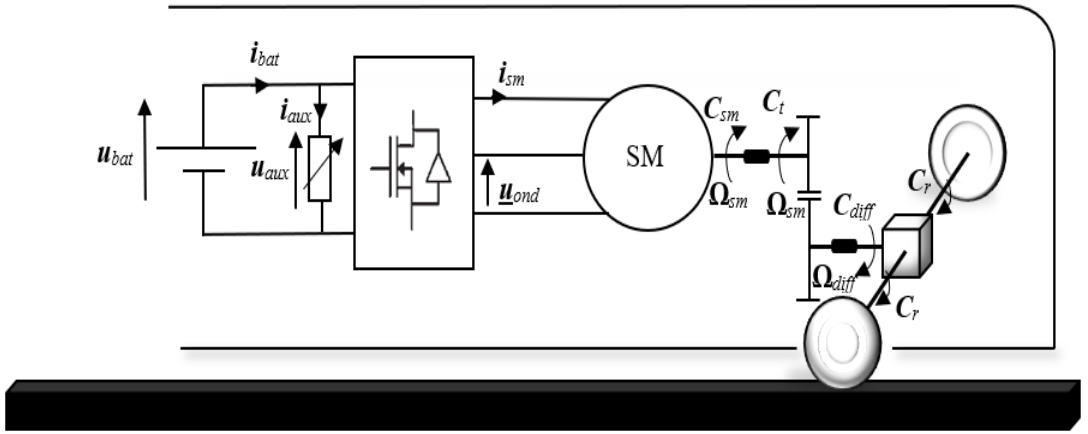
Objectif: Simulation of an e-bus to predict its energy consumption for different operation conditions.

Studied bus

E-ATAK: City bus From HCI- KARSAN

In operation in MEL
Since April 2023

Line C10, C11



Structural diagram of the studied bus

Characteristics:

- Li-ion battery: 220 kWh / 360 V
- Range: up to 300 km
- Charging time: 10 h (22 kW) 4 h (50 kW)
- Electrical drive: Synchronous machine (230 kW)

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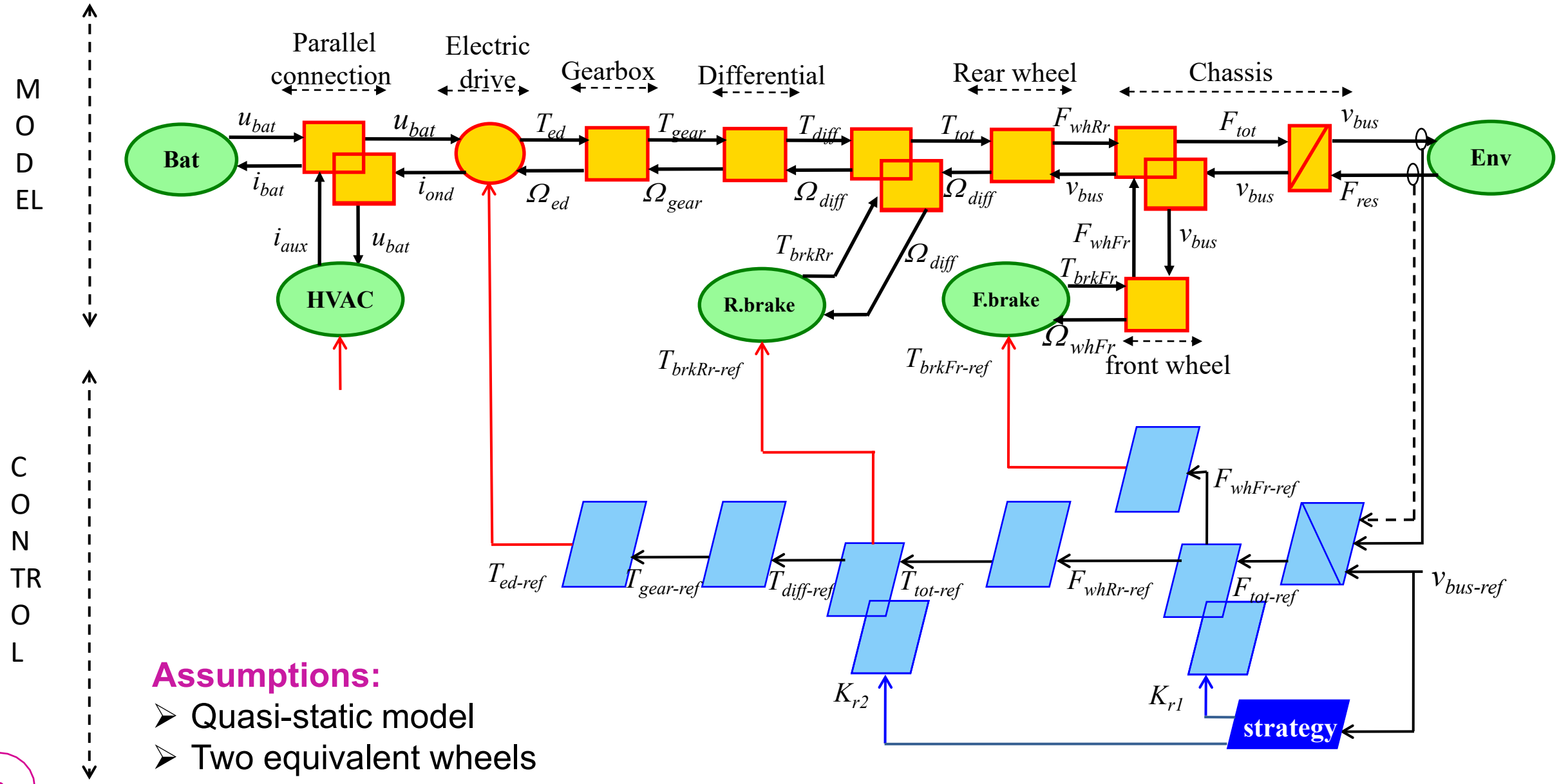
2. e-bus Simulation

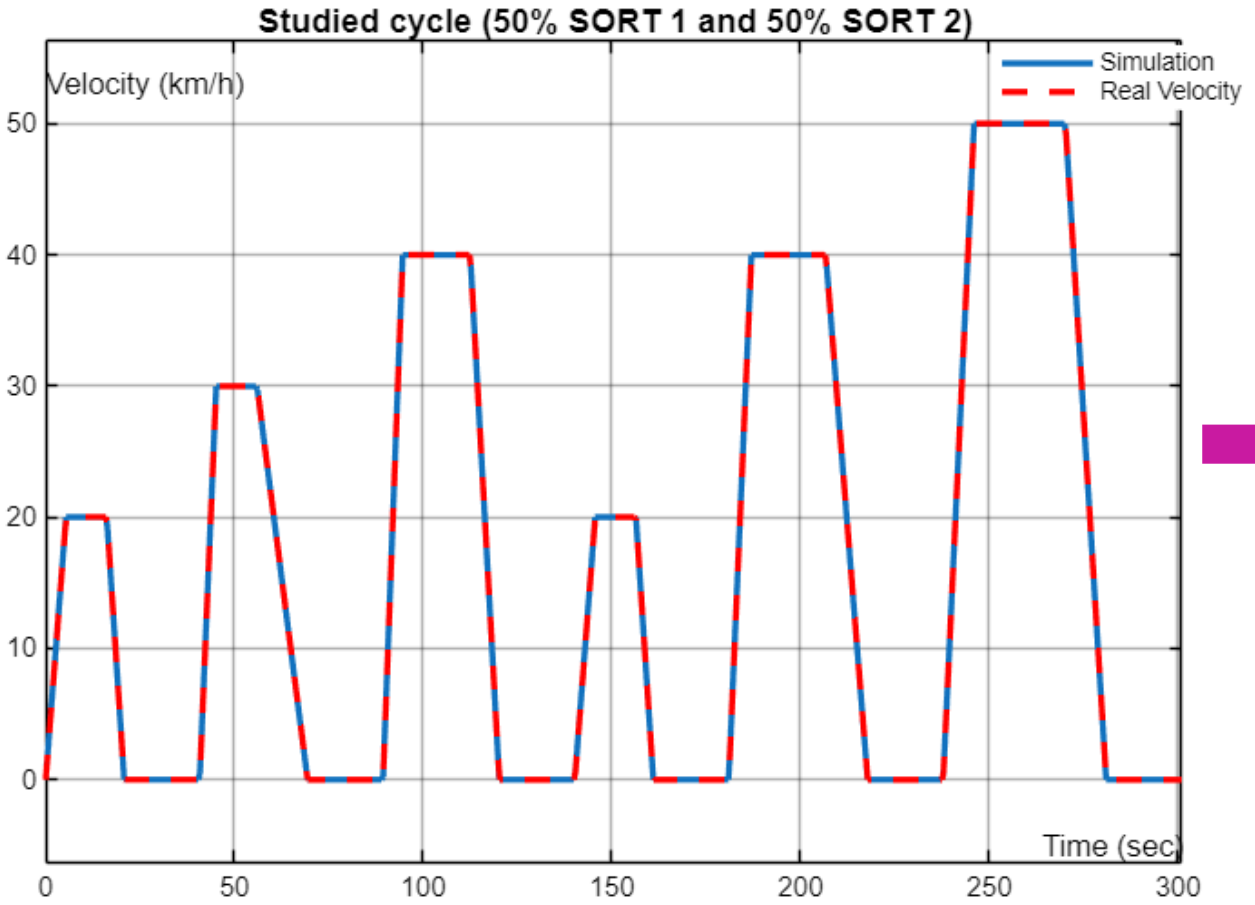
Model organization (EMR & MCS)



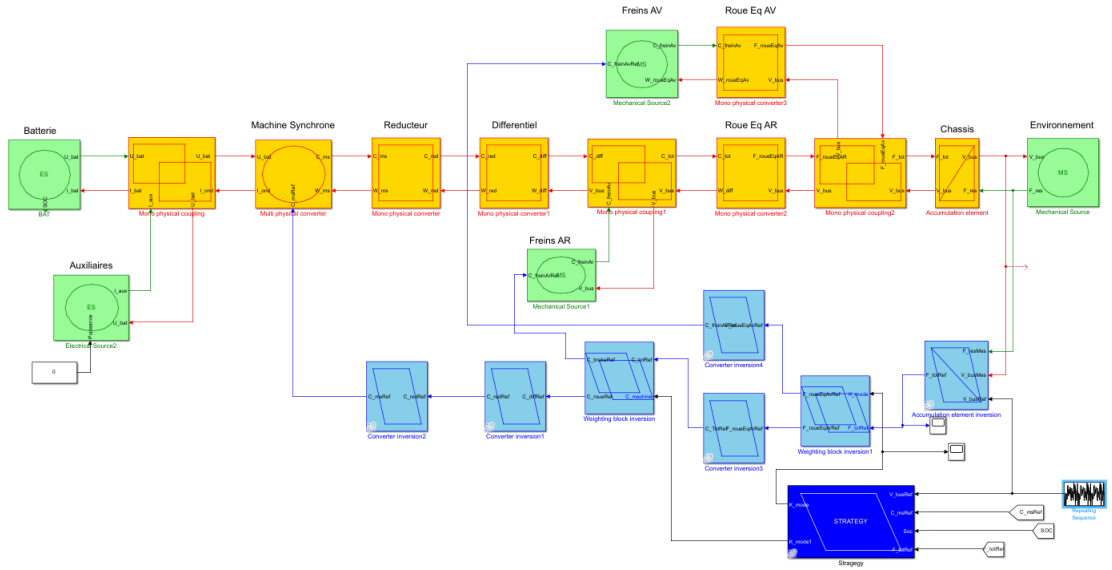
Assumptions:

- Quasi-static model
- Two equivalent wheels
- Slope and wind neglected

Model validation with SORT cycle



MALTAB-Simulink



Consumption and driving range reference:

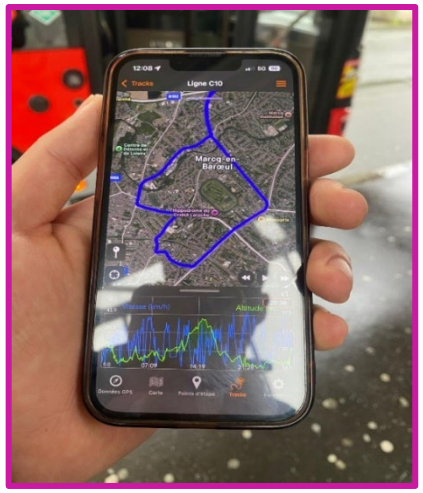
- Driving range: 343 km
- Consumption: 0.62 kWh/km

Simulation results:

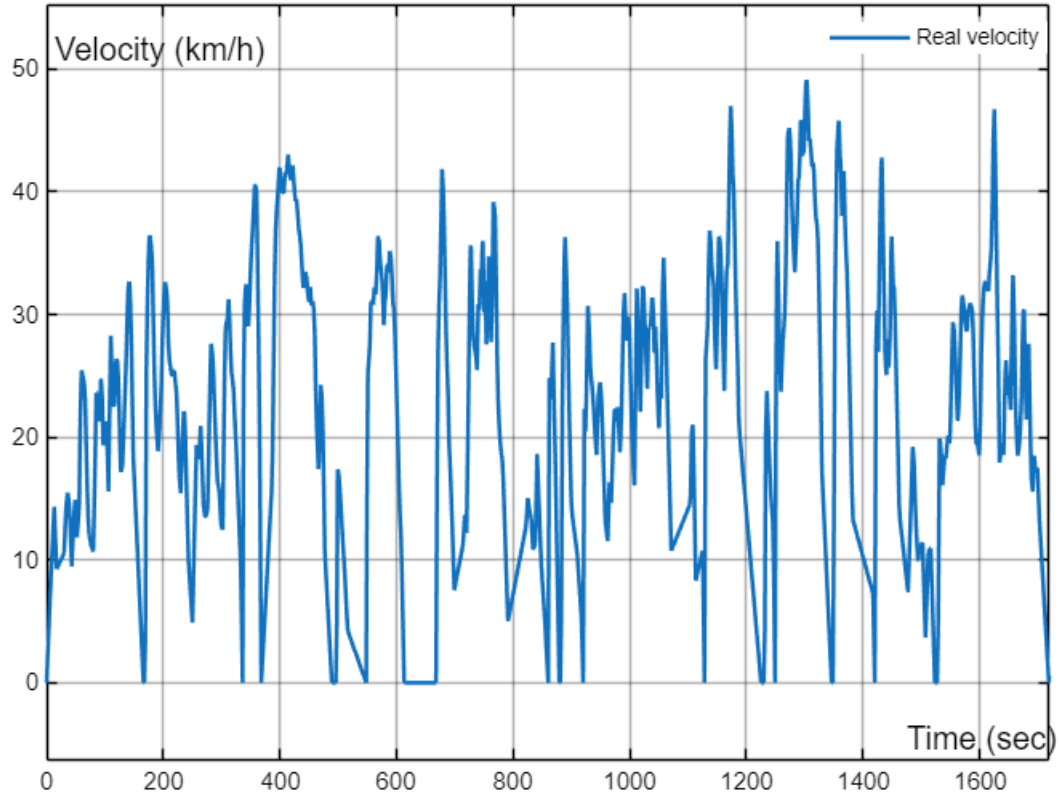
- Driving range: 338 km
- Consumption: 0.63 kWh/km

Accuracy 98.6%

Measurement of a real driving cycle



GPS Tracks from AppStore



Geographic map of the C10 bus line

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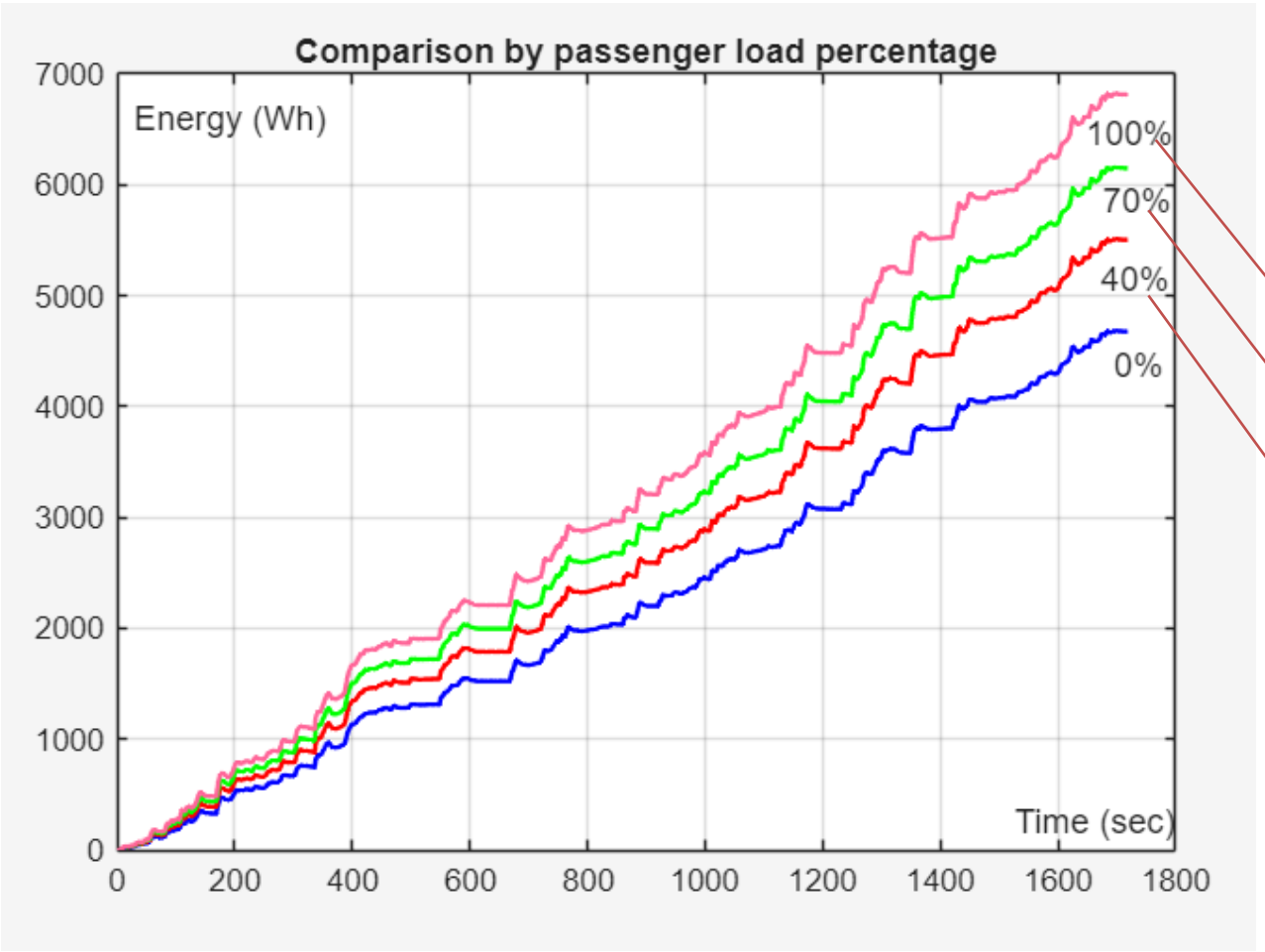
3. Energy Consumption variations

Impact of mass on energy consumption



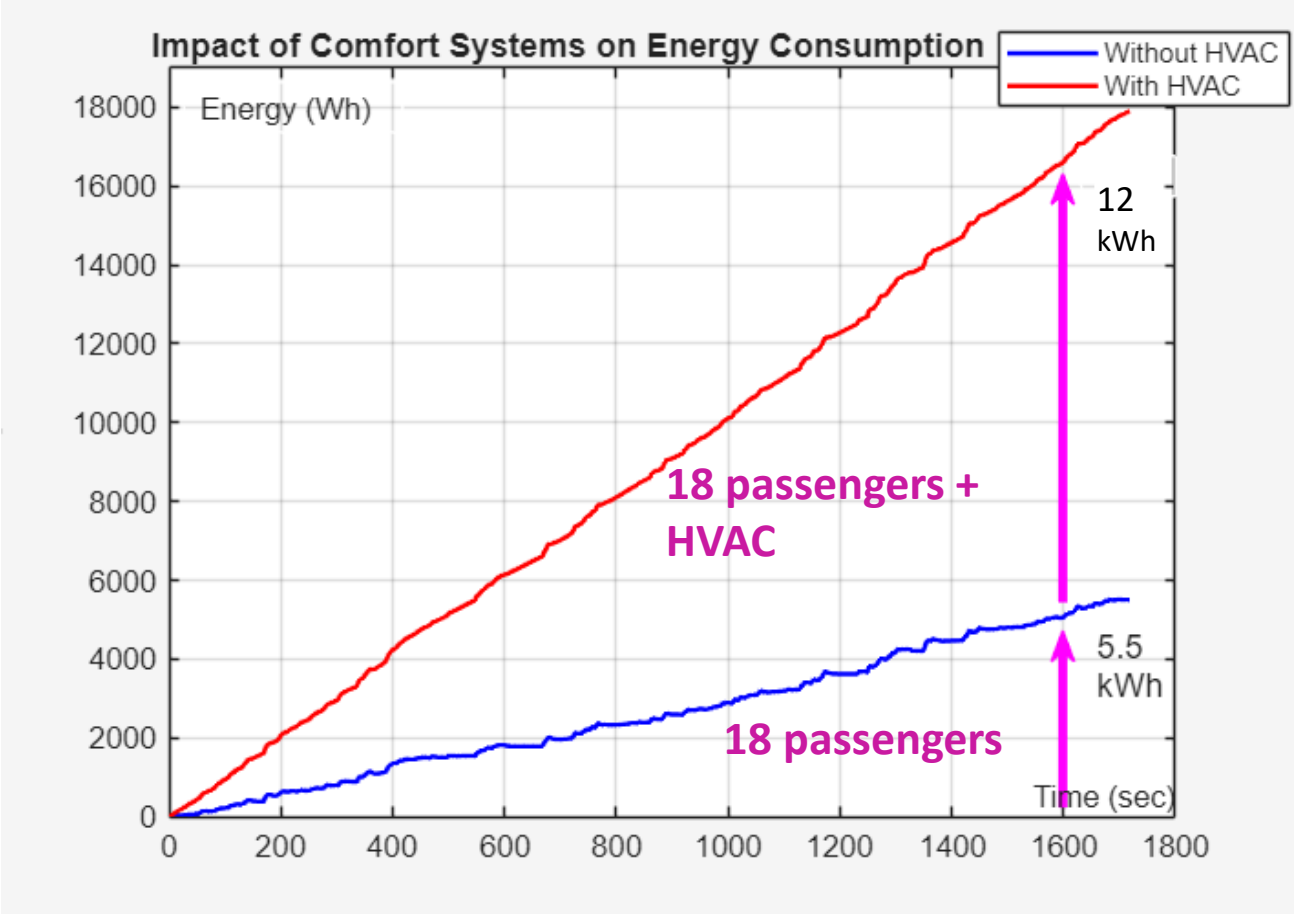
Considered scenarios:

- 0% passenger load (empty bus)
- 40% passenger load (18 passengers)
- 100% passenger load (46 passengers)

For 40% passenger load → + 17% of energy
For 100% passenger load → + 46% of energy

"The bus mass affect energy consumption adding over 45% on energy consumption."

Impact of comfort systems on energy consumption



Considered scenarios(40% load (18 passengers)):

- without HVAC
- with HVAC at maximal power

" Note that in practice, the comfort systems power is not constant and changes with external temperature."

Maximal power for comfort systems (26 kW) → ~20 % of energy consumption

HVAC: heating, ventilation and air-conditioning

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4. Conclusion

Conclusion

Summary:

- MATLAB-Simulink Simulation based on Energetic Macroscopic Representation (EMR)
- Simulation validation (error < 2% on energy consumption)
- Measurement of a real driving cycle
- Maximal mass → + 46% on energy consumption
- Maximal HVAC → + 200% on energy consumption

Perspectives:

- Integrate real-world tests to validate and adjust the model
- Integrate the HVAC in simulation
- Integrate auxiliary systems in simulation
- Develop a real-time simulation for a digital twin (as need by CUMIN-BEN and CODE4EV)

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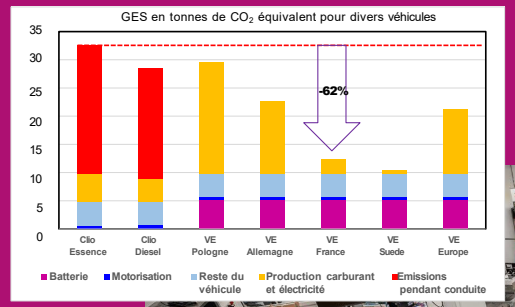

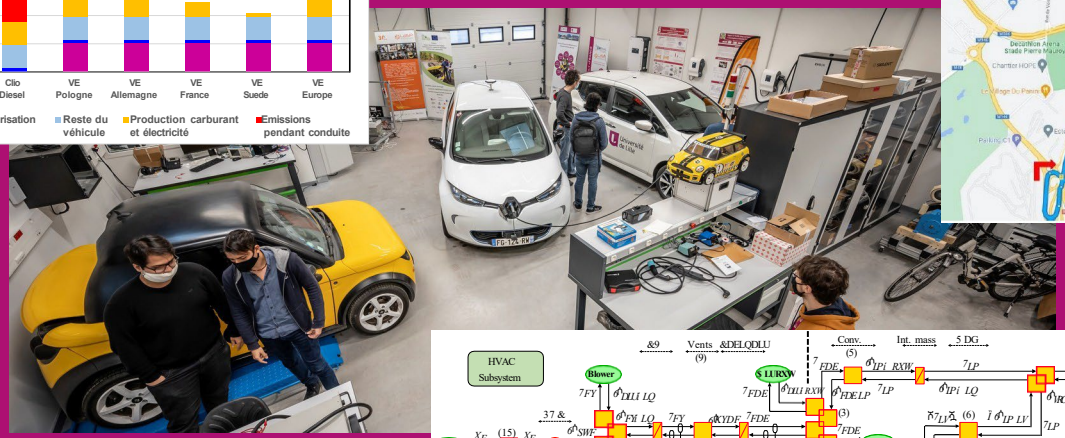

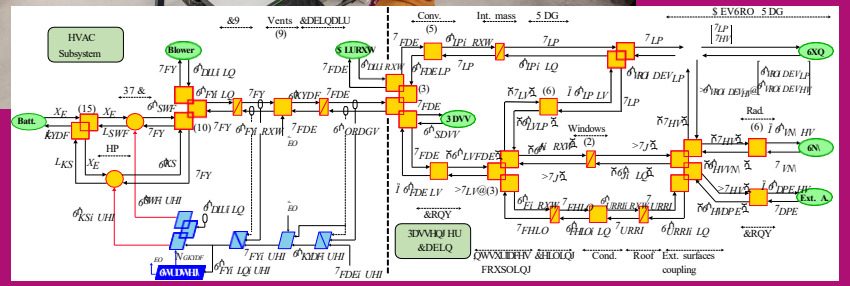

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