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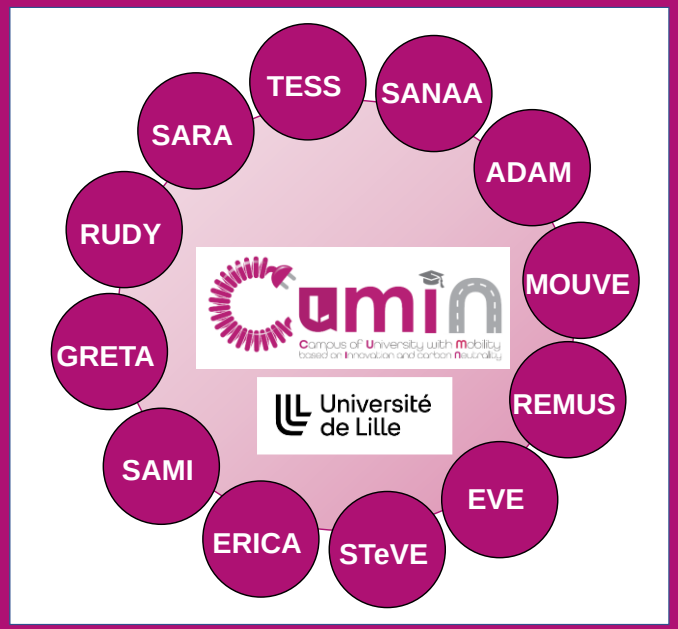


CUMIN - REMUS

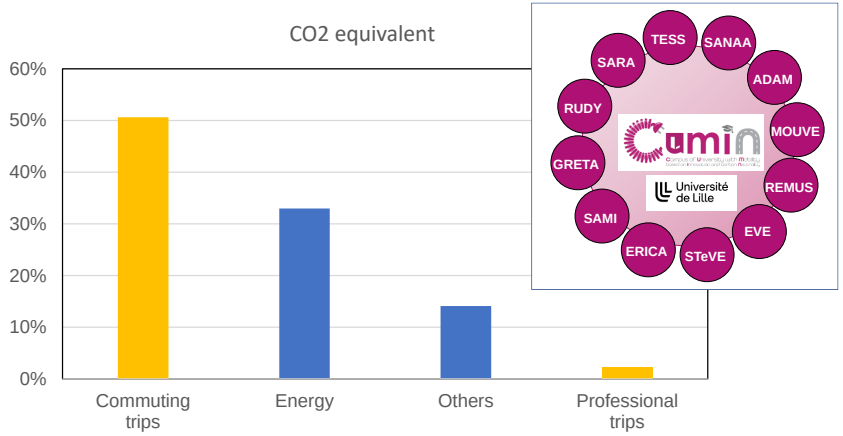
GHG emission from commuting

C. Mayet, P. Delarue,
A. Bouscayrol, C. Brocart

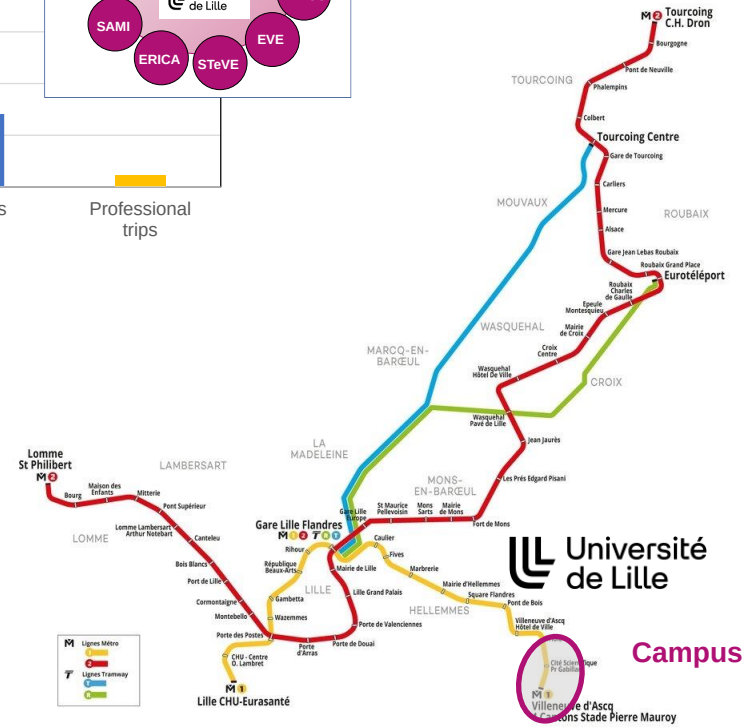
University of Lille, L2EP
European Metropolis of Lille (MEL)

Context and Objective

- Reduce the global GHG Emission in ULille



REMUS – Recovery of "Metro" Braking Energy for a Sustainable University



REMUS ⟷ EVE

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

Région Hauts-de-France

MEL MÉTROPOLE EUROPÉENNE DE LILLE

Metro
R. O. BERRIEL (Ph.D.)
22/12/2023

New subway (line 1)

New vehicle

Actual vehicle

Tramway
MEL Internship (2024)
M2 VIE Project (2025)

New tramway

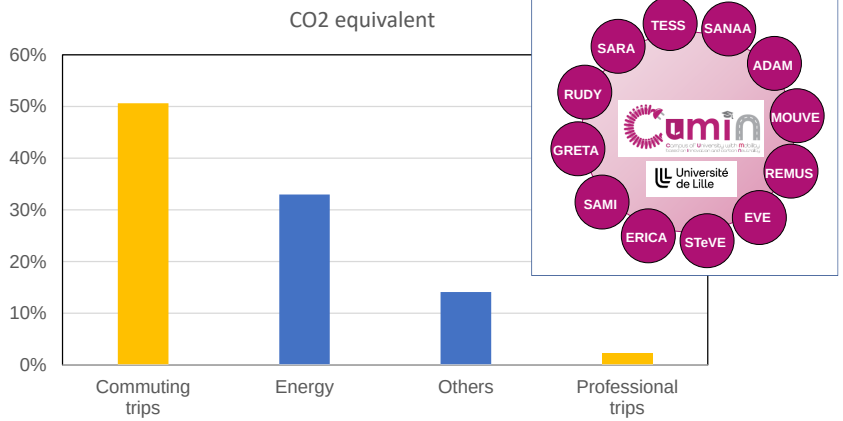
Bus
M2 VIE Projects
(2024 & 2025)

New e-bus

Context and Objective

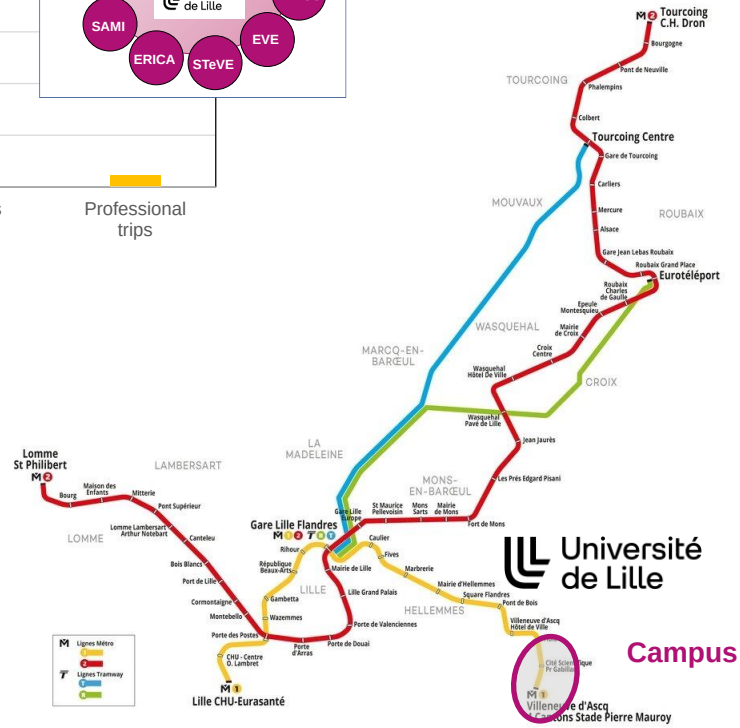
- Reduce the global GHG Emission in ULille

REMUS – Recovery of “Metro” Braking Energy for a Sustainable University



Reduction of energy consumption of metro and tramway systems?

Comparison with other transport modes?



New subway (line 1)

New vehicle

Actual vehicle

New tramway

New e-bus

Scenarios

Daily round-trip (commuting)

Indicators

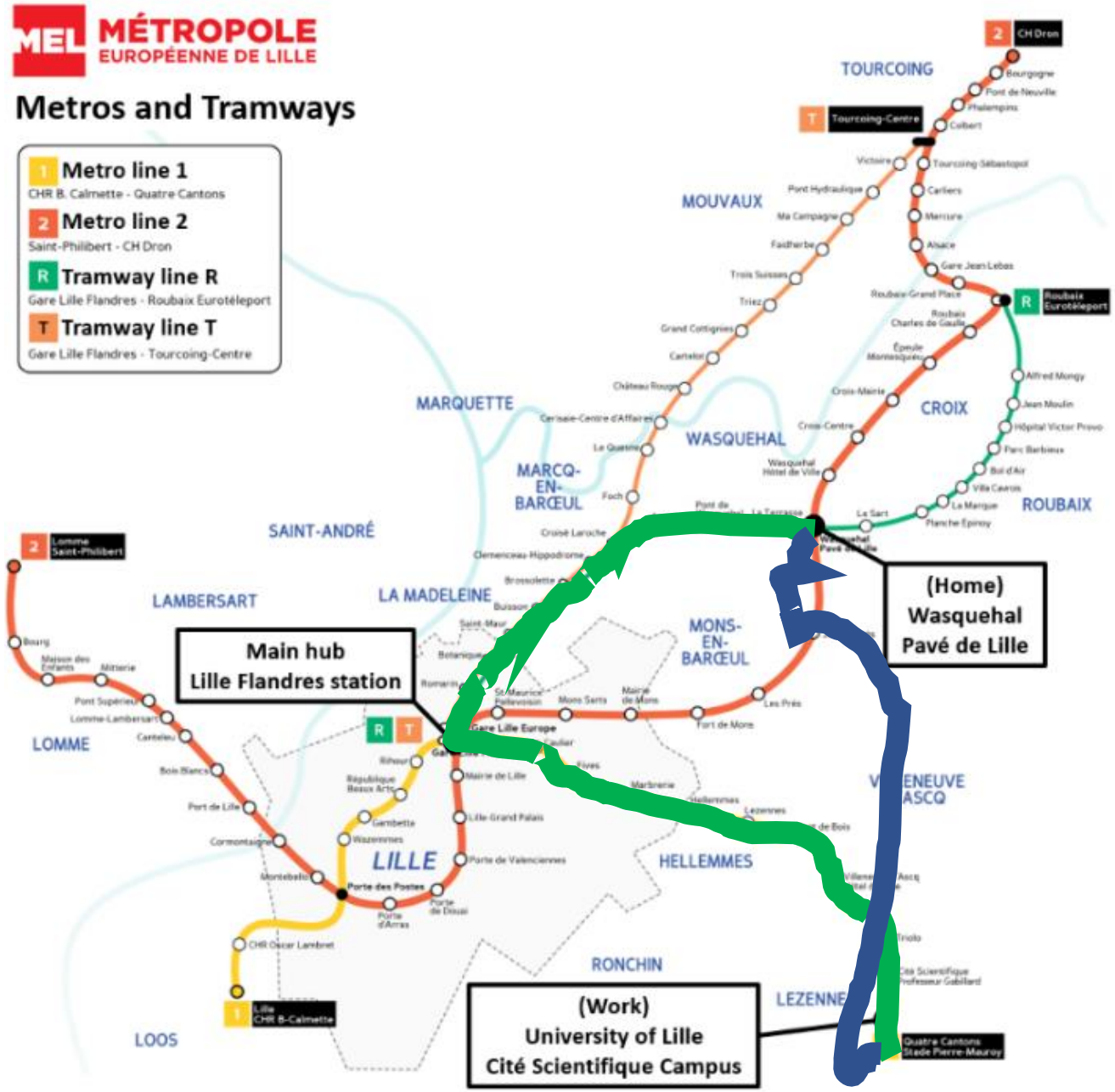
Energy consumption
GHG emission
Travel time
Direct personal costs

Comparisons

Use of Tramway R + Metro line 1

Use of personal ICE vehicle

Require models and simulation tools



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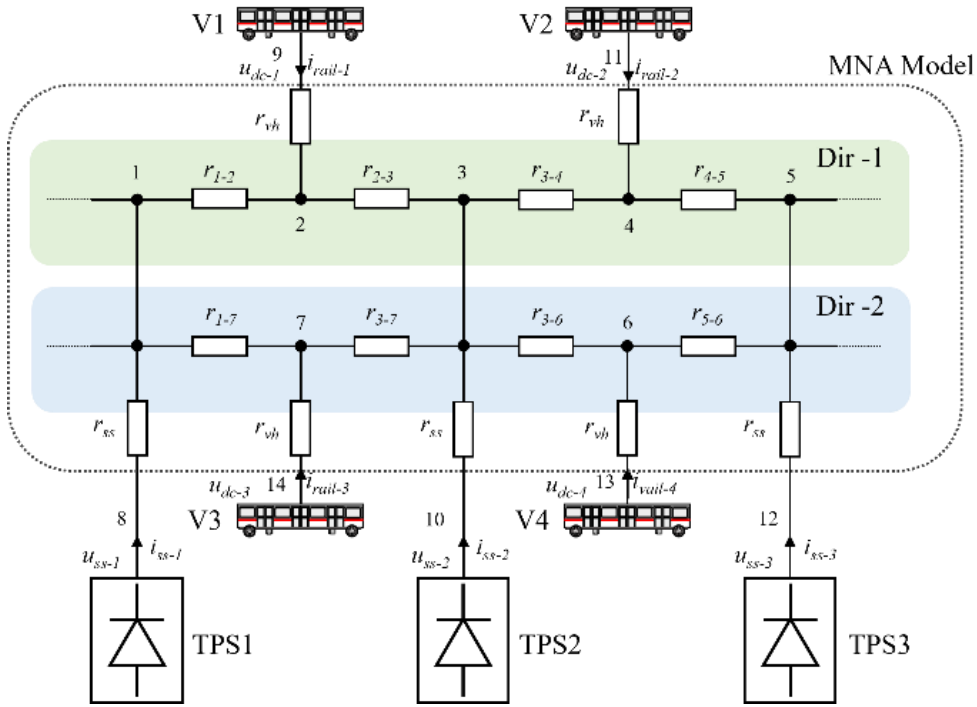
Model of metro and tramway systems

Simulation of subway systems

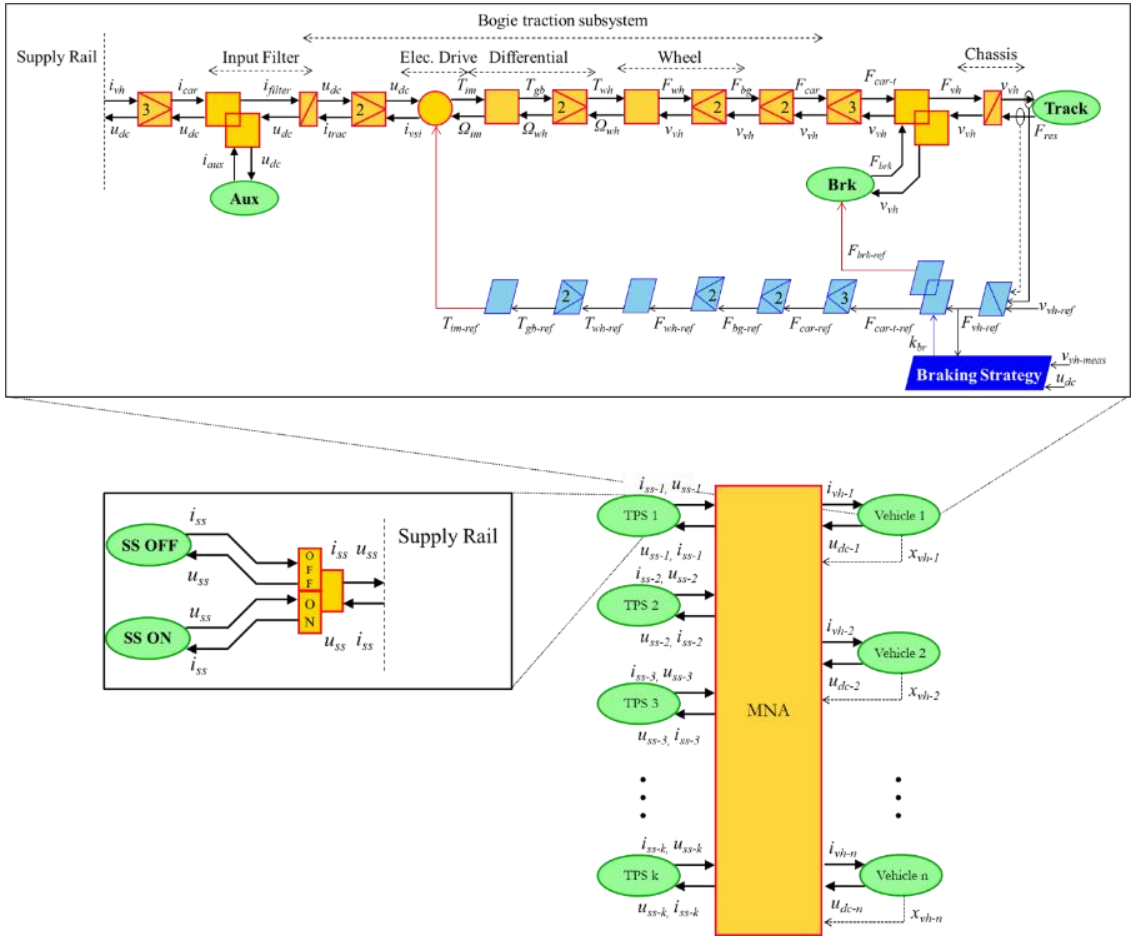
Complex model (validated)

Estimate energy consumption for various scenarios



Model from previous works

Energetic Macroscopic Representation (EMR)

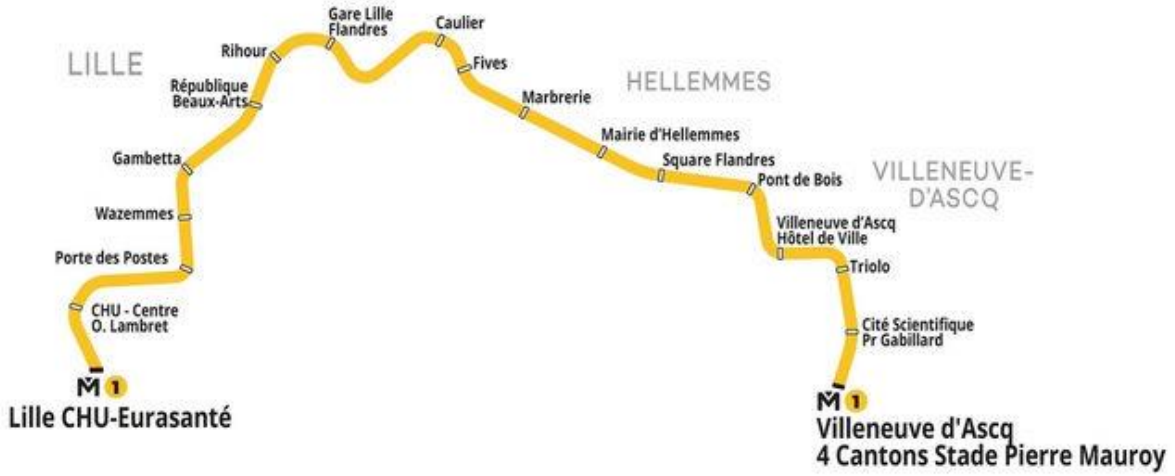


Simulation of the new subway (NMR)

Carrousel simulation

Multiple vehicles circulation
34 vehicles on peak-hours & 10 TPS

Respecting timetable
About 19h of operation

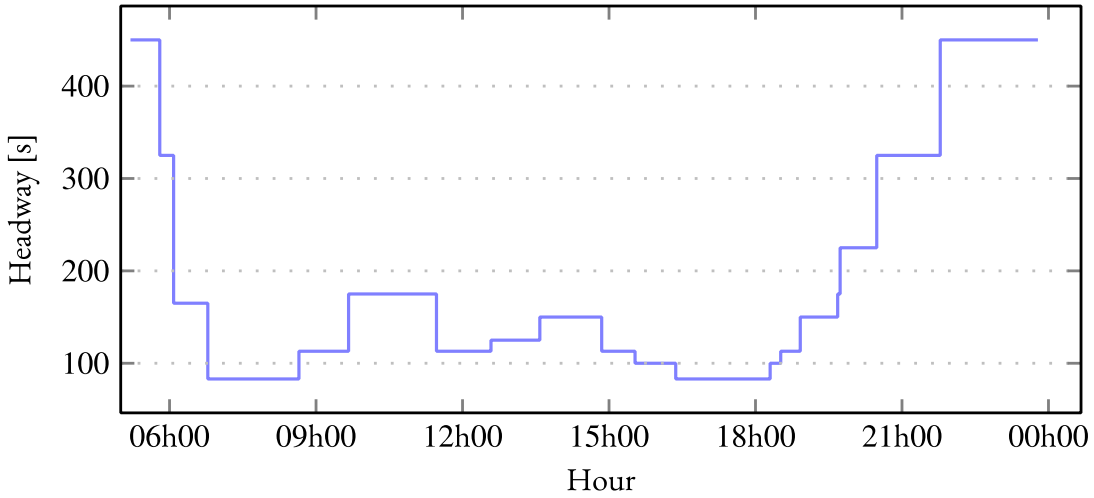


Daily key numbers:

Total energy: 82.6 MWh
Total distance: 10653.6 km
306 passengers per vehicle in average

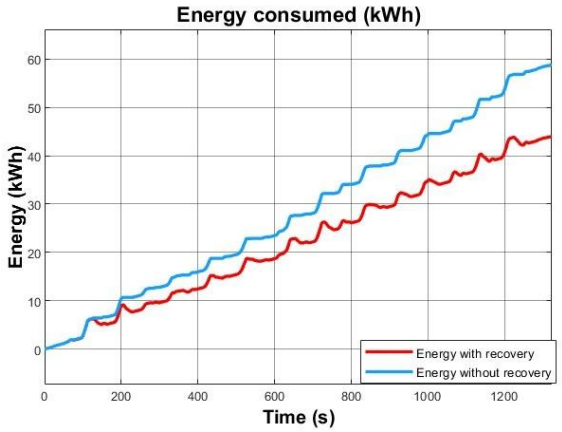
25 Wh/pass.km

Timetable



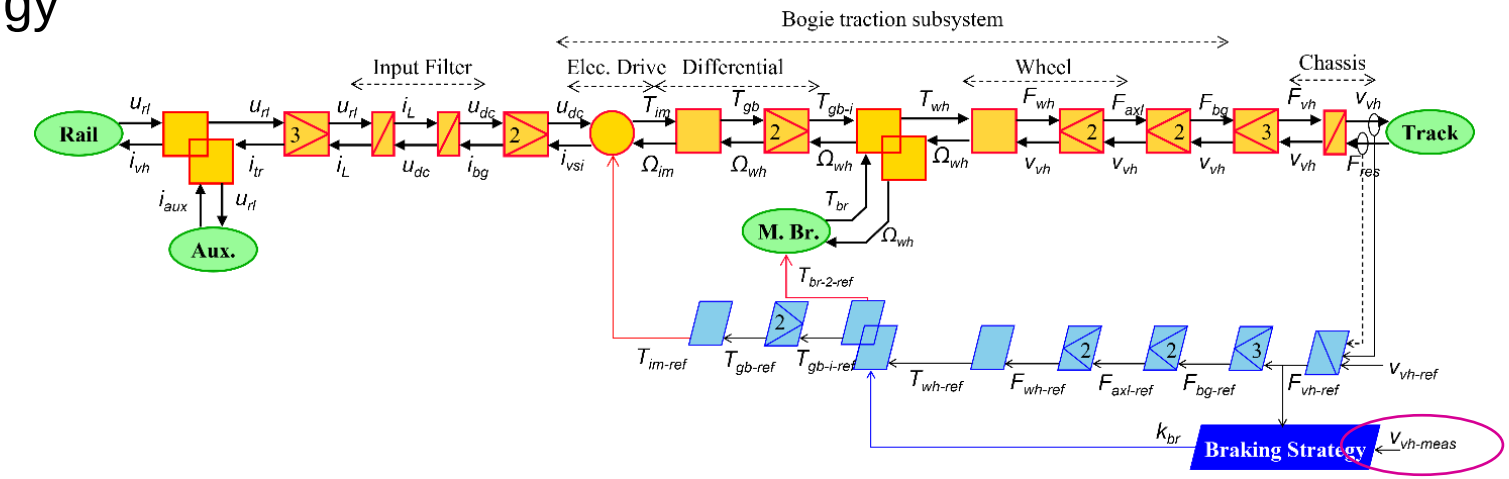
Simulation of the new tramway (CITADIS)

Next presentation



Total line energy consumption

Tramway simulation

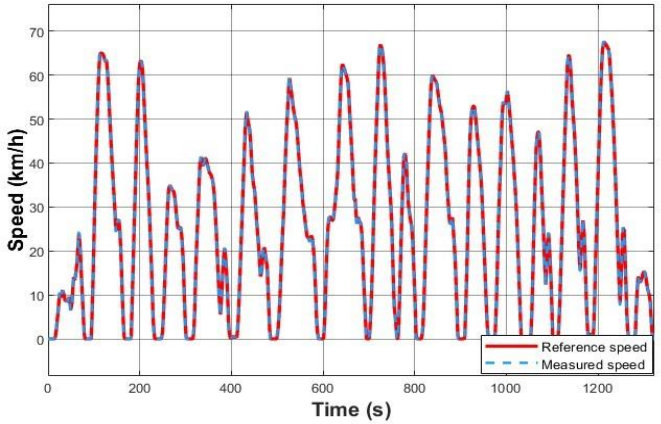


Key numbers (3600s simulation):

Total energy: 528.9 kWh
Total distance: 99.84 km
200 passengers per vehicle in average

26,5 Wh/pass.km

Real measured driving cycle



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Comparative analysis

Simulation results

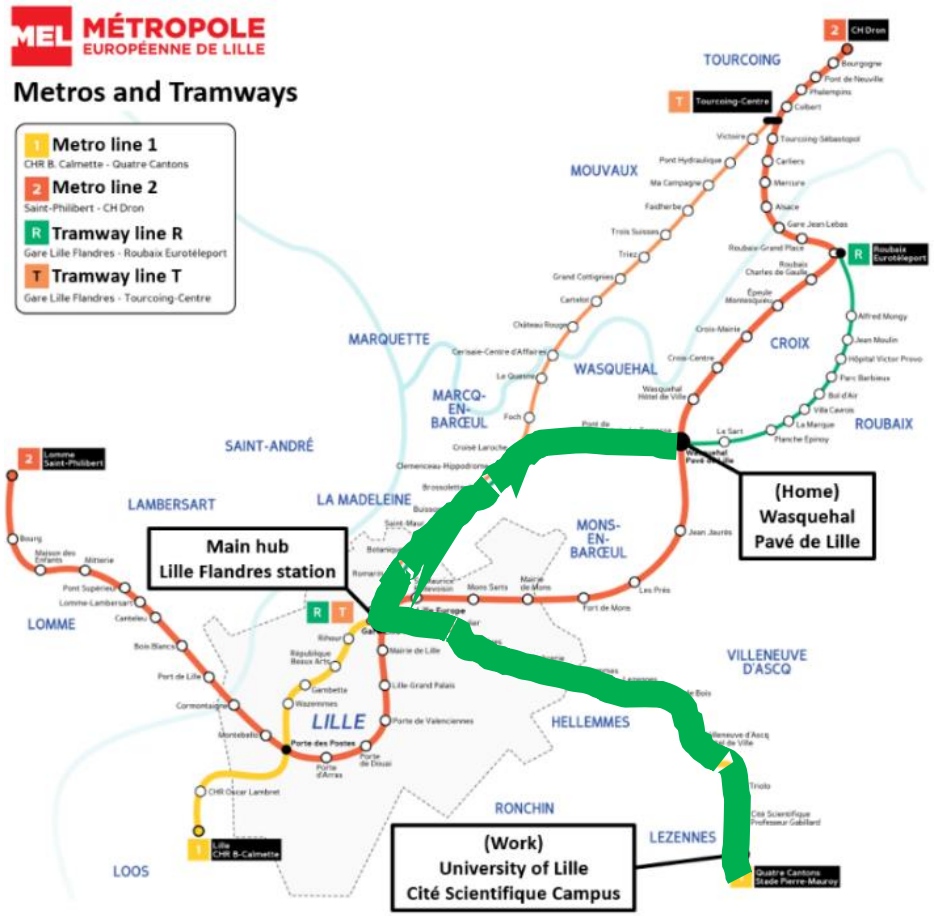
Rail public transportation (commuting)

Daily indicators per person

Transport	Distance	Energy	CO2eq
Tramway	8.8 km	233.2 Wh	7.5 g
Subway	15.2 km	384.6 Wh	12.3 g
Total	**24 km**	**617.8 Wh**	**19.8 g**

32 gCO2eq/kWh (RTE, 2023)

Well-to-Tank (WTT 100%) → Tank-to-Wheel (TTW 0%)



Other daily indicators per person:

- 72 min round trip
- 1.45 € per day (annual pass)

Simulation results

Personal gasoline car (commuting)

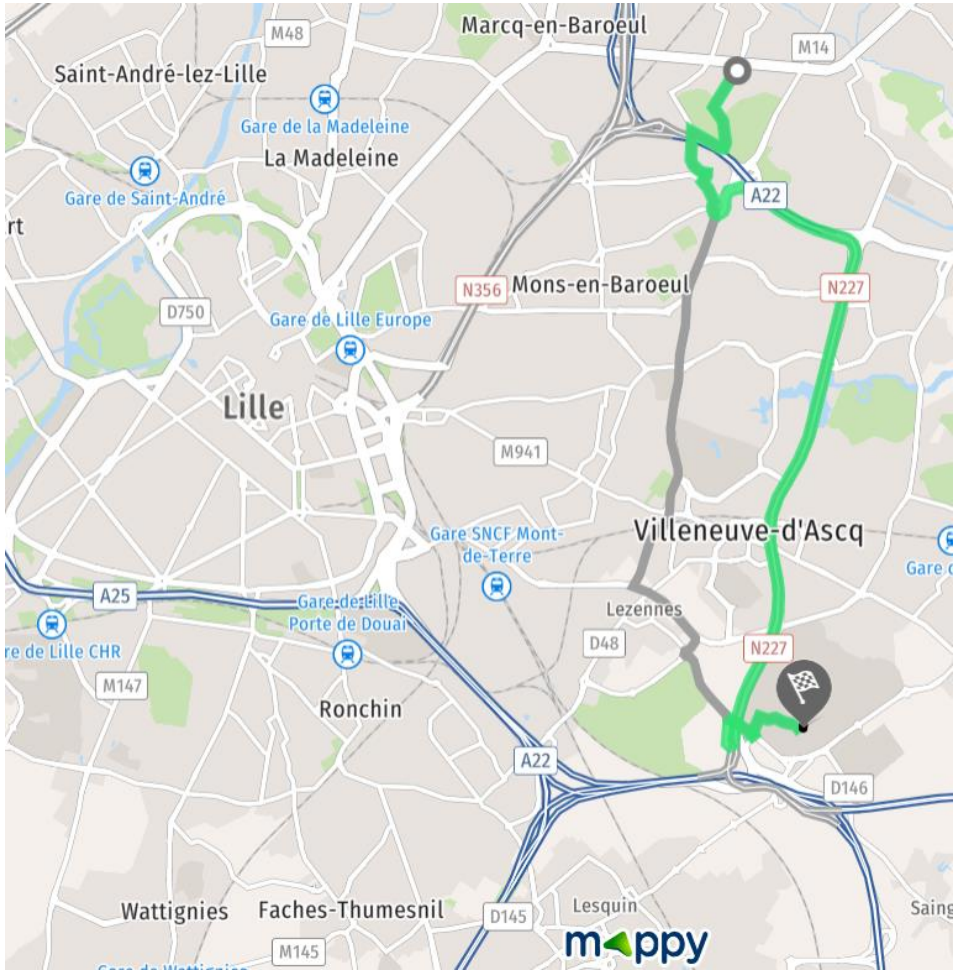
Model from previous work

Daily indicators per person

Transport	Distance	Gasoline	CO2eq
Car	19.6 km	0.94 L	2459.8 g

14.5 gCO2eq/L — Well-to-Tank (WTT 11.5%)

111 gCO2eq/L — Tank-to-Wheel (TTW 88.5%)



Other daily indicators per person:

- 30 min round trip
- 1.76 € per day (1.88 €/L in 2023)

Conclusion & Perspectives

Conclusions

- Simulation of the future public rail transport (new metro + new tramway)
- Estimation of several daily indicators (GHG, energy, journey time, cost, etc.)
- Comparison with gasoline cars

Indicators	**Gazoline car**	**VS**	**Rail public transport**
GHG	2459.8 g CO2eq	÷ 124	19.8 g CO2eq
Travel time	30 min	× 2.4	72 min
Direct personal costs	1.76 €	÷ 1.2	1.45 €

Perspectives

- Consideration of other transport systems (buses, electric bicycles, etc.)
- Complete life cycle analysis (LCA) to refine environmental comparisons
- Estimation of other indicators (cost to society, stress factor, human factor, etc.)

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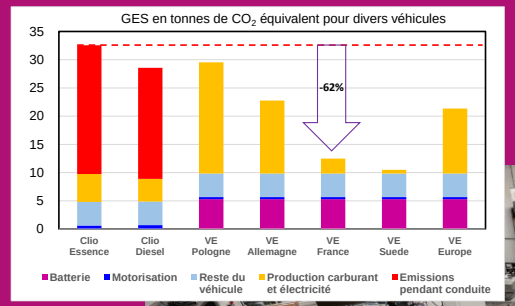

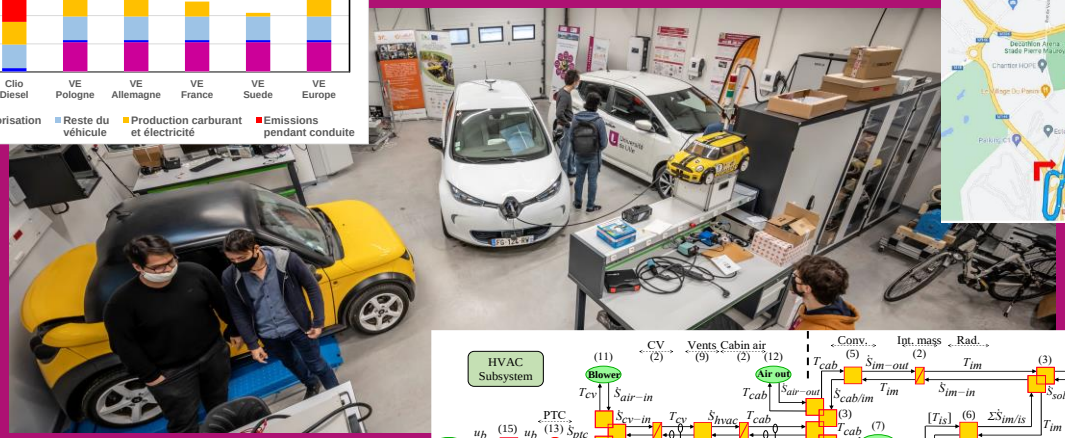

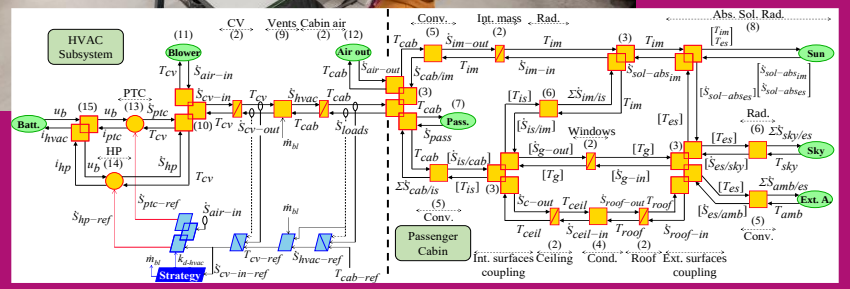

Our university as an exciting living lab towards eco-cities through an innovative transdisciplinary framework !