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Tramway energy consumption

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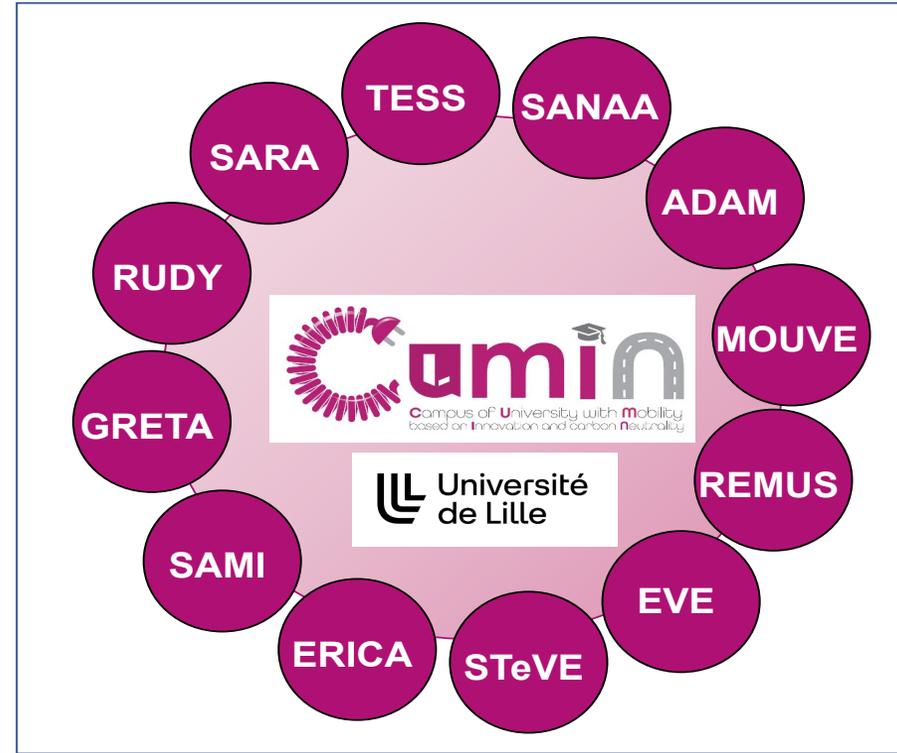# Presentation Outline

Context & Objective

- Reduce the global GHG Emission in ULille

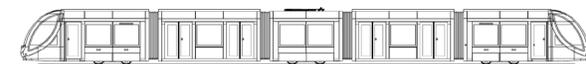**REMUS – Recovery of "Metro" Braking Energy for a Sustainable University**

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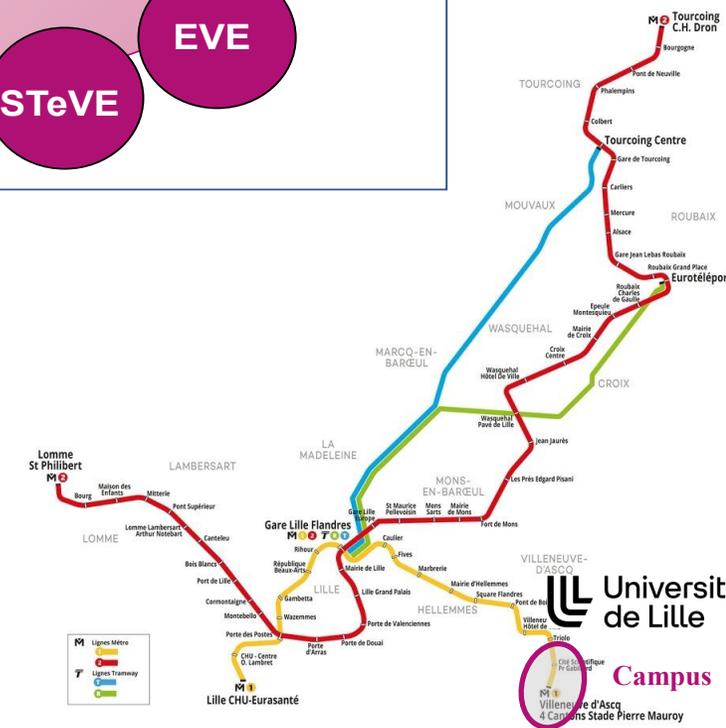R. O. BERRIEL (Ph.D.)
22/12/2023

New subway (line 1)

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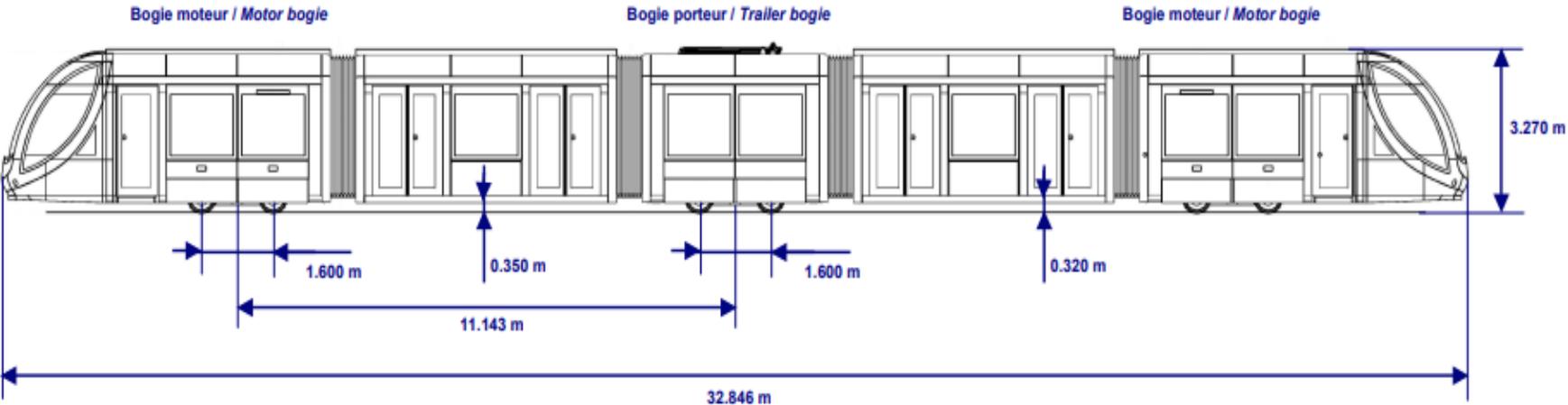MEL Internship (2024)
M2 VIE Project (2025)

New tramway

New vehicle

Actual vehicle

Citadis X03.1

Bogie moteur / Motor bogie   Bogie porteur / Trailer bogie   Bogie moteur / Motor bogie

3.270 m

1.600 m   0.350 m   1.600 m   0.320 m

11.143 m

32.846 m
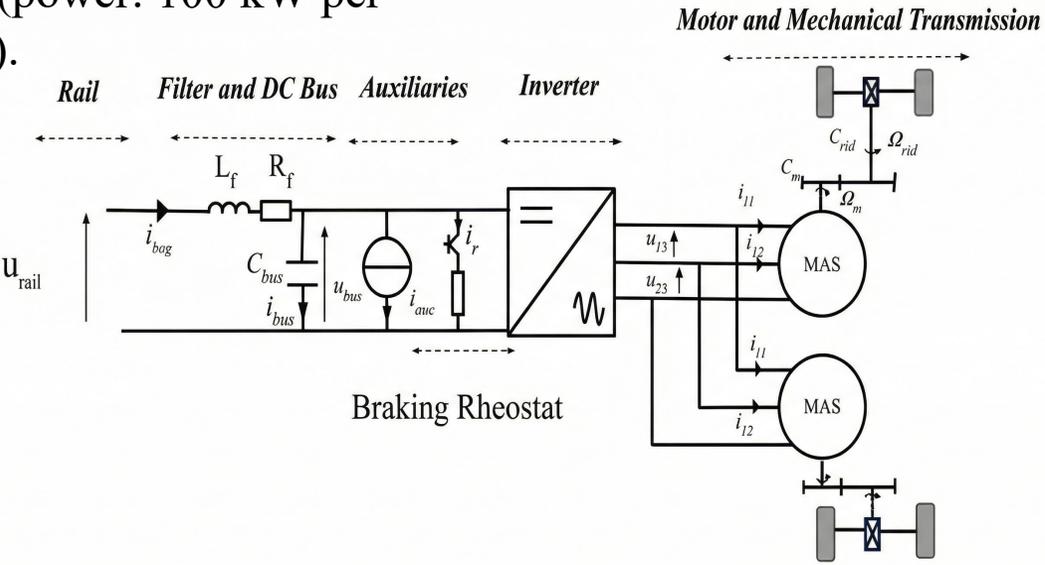
- Structure: 4 bogies in total, including 2 powered bogies.

- Motorization: 2 induction machine motors per powered bogie (power: 100 kW per motor).

Source:http://fbrisou.free.fr/RAIL21/FicheCIT-Bordeaux.pdf

Motor and Mechanical Transmission

Rail   *Filter and DC Bus*   *Auxiliaries*   *Inverter*

L_f R_f

i_{bag}

u_{rail}

C_{bus} u_{bus} i_{auc} i_r

i_{bus}

Braking Rheostat

u_{13} u_{23}

i_{l1} i_{l2} MAS

C_{rid} Ω_{rid}

C_m Ω_m

i_{l1} i_{l2} MAS

Let's move on to the simulation part
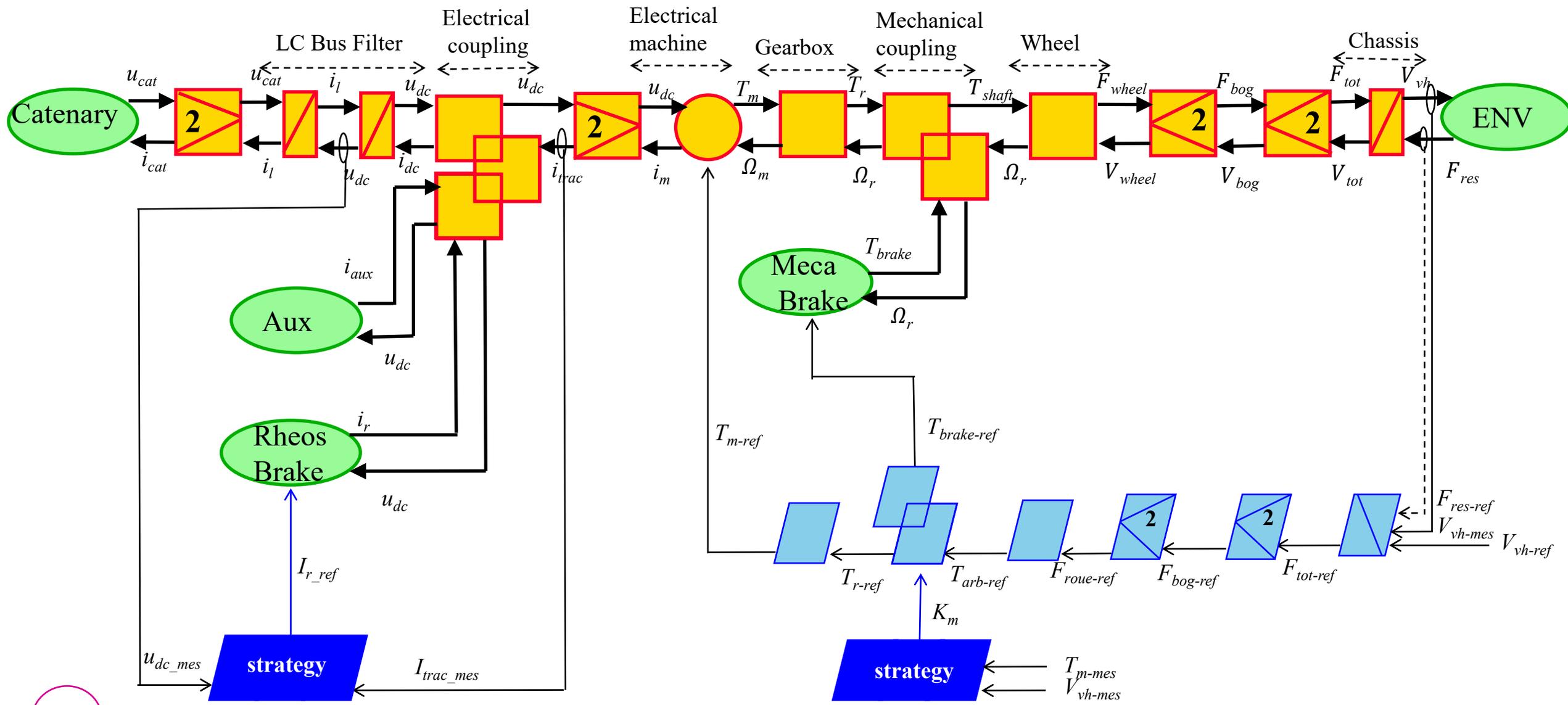
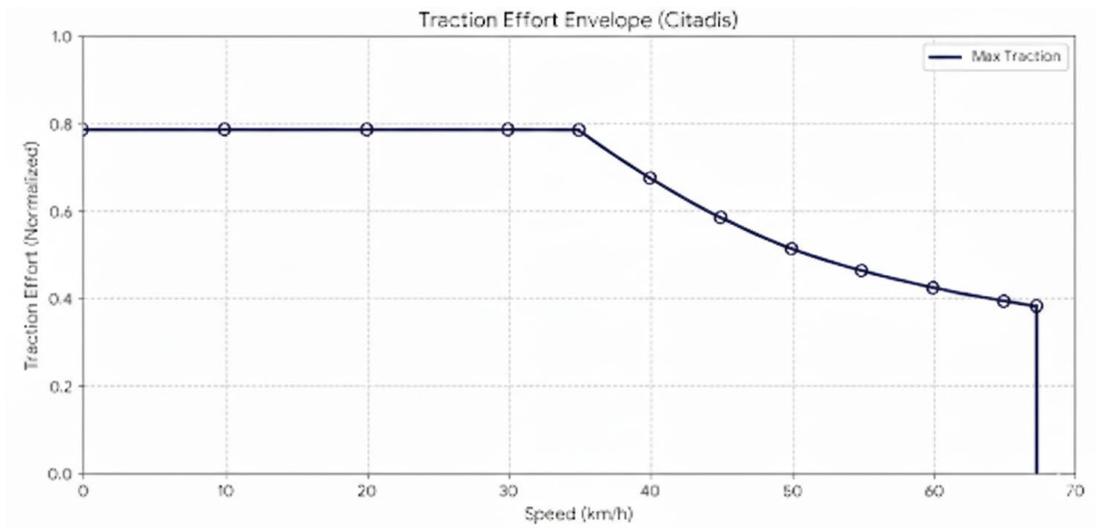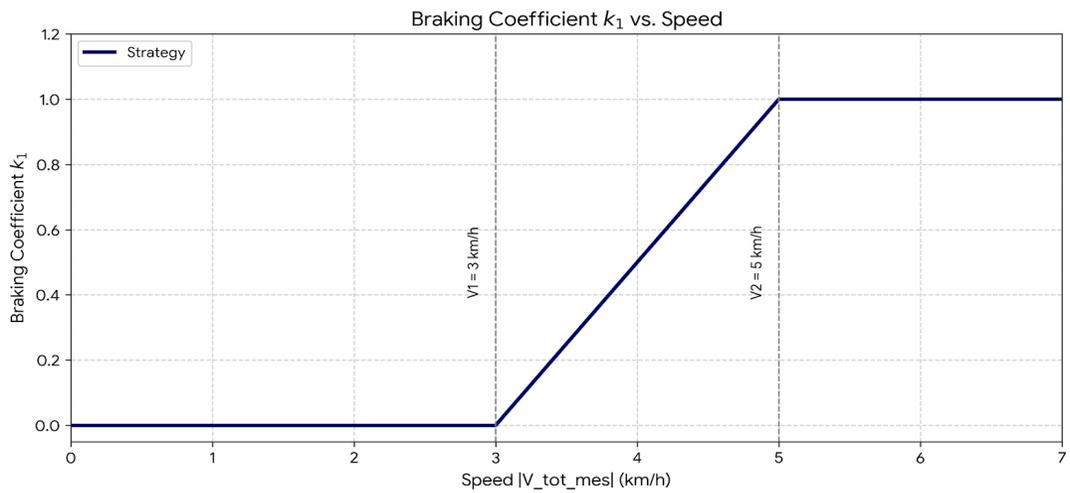

Source:http://fbrisou.free.fr/RAIL21/FicheCIT-Bordeaux.pdf

Simulation of tramway Citadis 03.1

EMR & MCS

Braking strategy

- **Mechanical brakes**

Braking Coefficient k_1 vs. Speed

Traction Effort Envelope (Citadis)
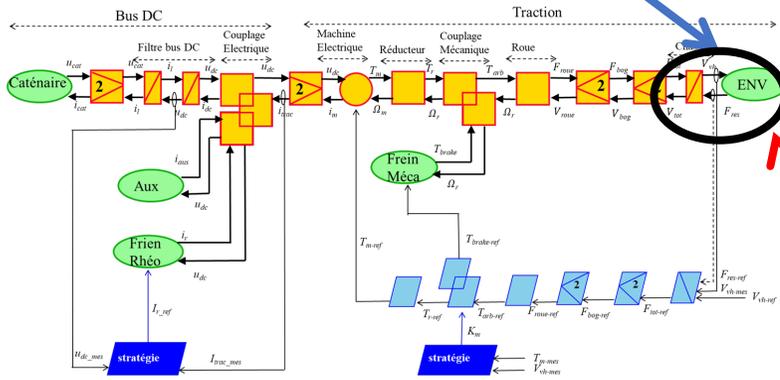
- **Electrical brakes**

Rheostatic Braking Coefficient ($k_{rheostat}$) vs DC Bus Voltage
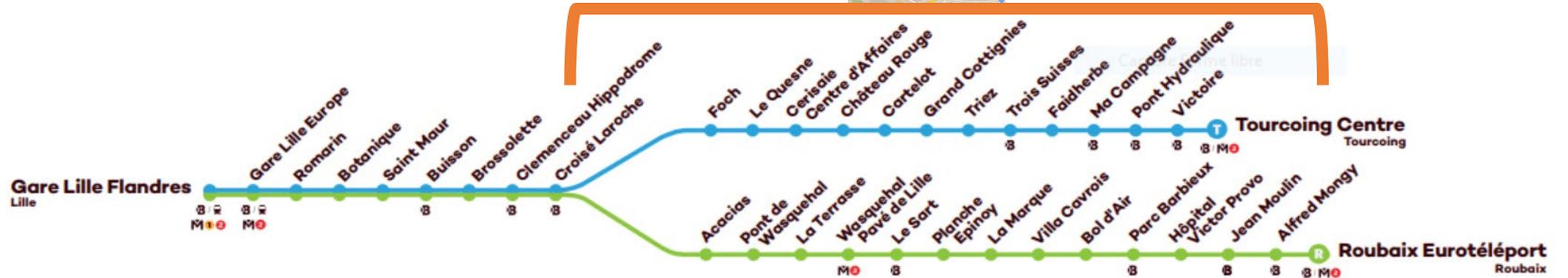
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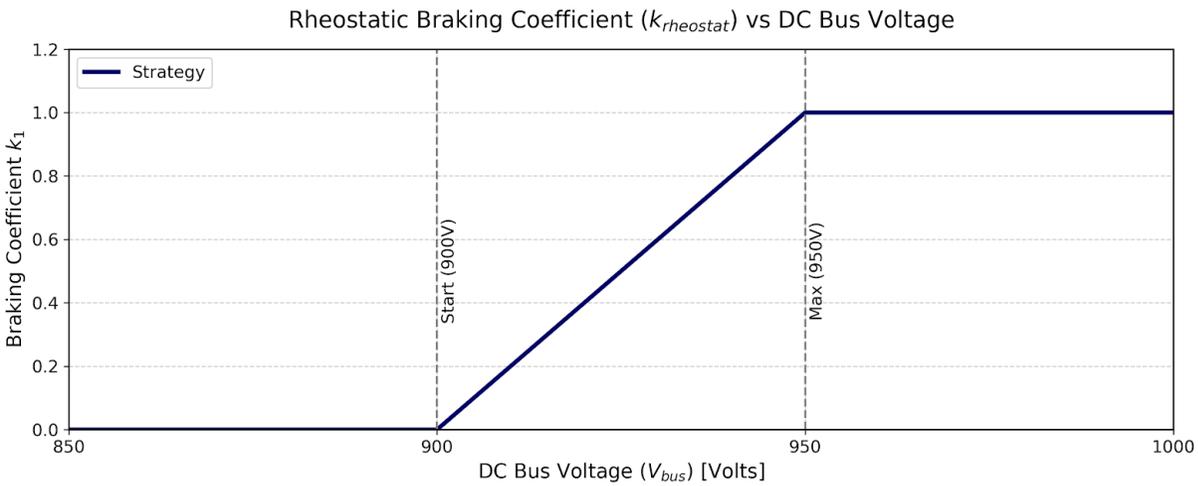
Validation of the Model

Validation of the model

Speed variation

Energy Consumption Comparison: Alstom Simulation vs Project Simulation

6,19% error

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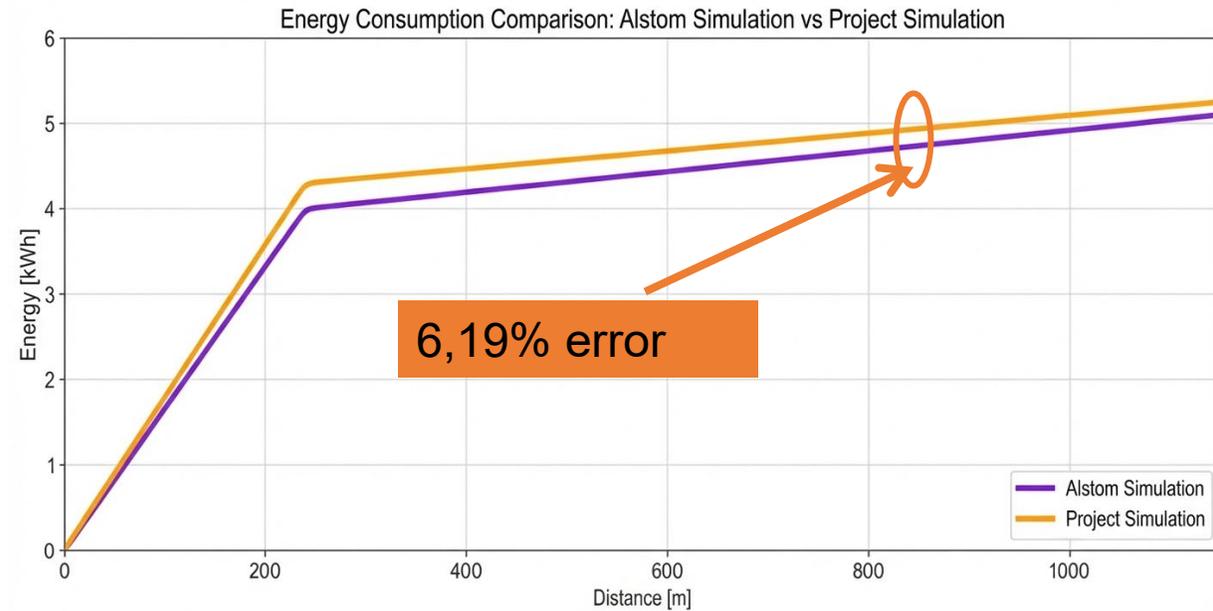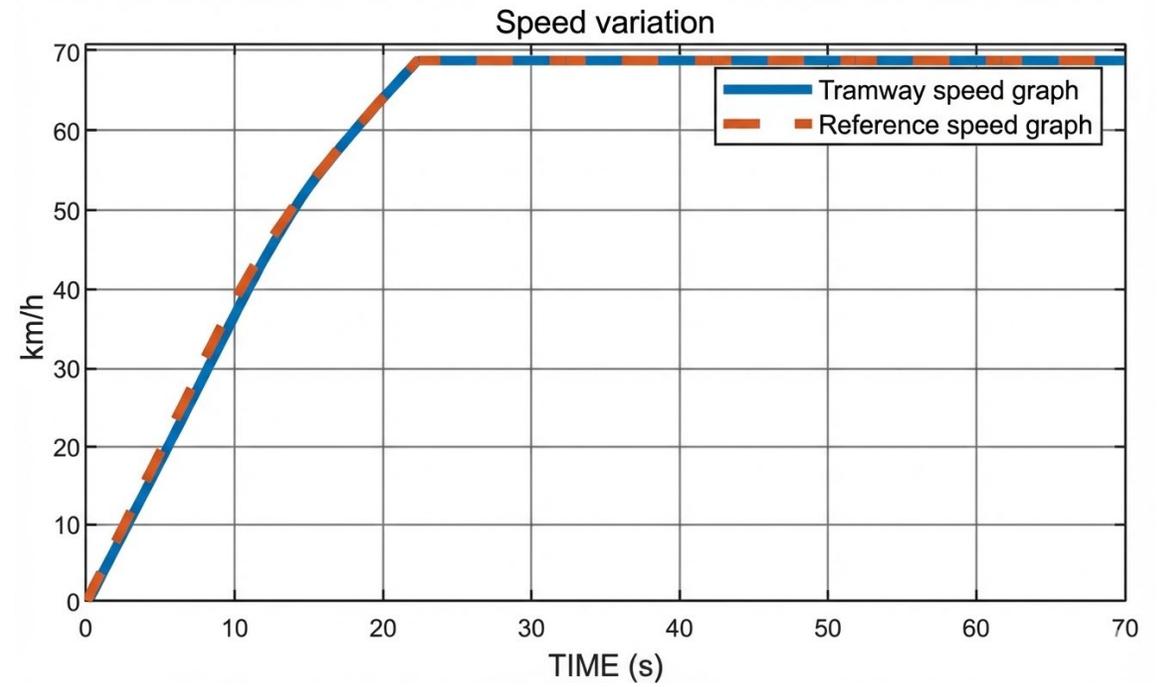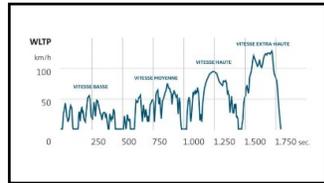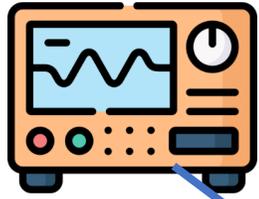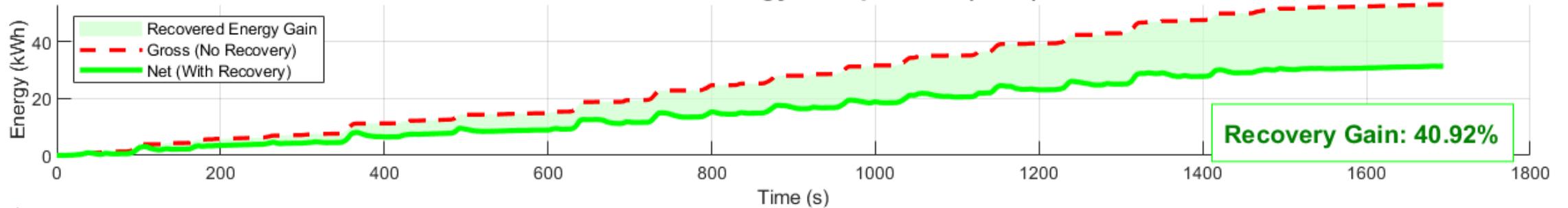
Simulation Results
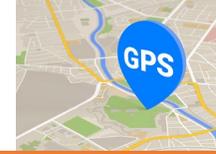
Speed Profile: Croisé Laroche to Tourcoing Centre
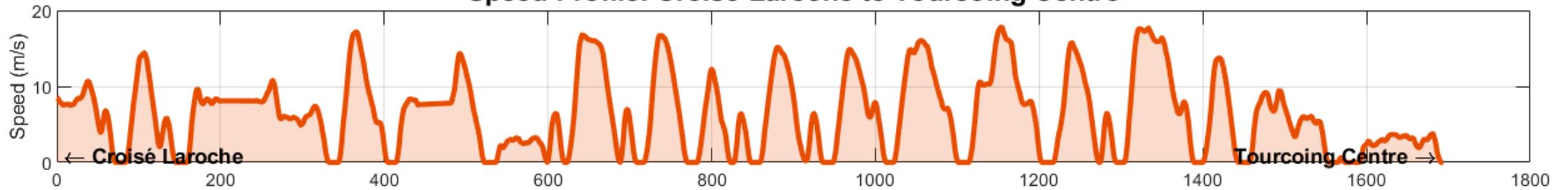
Cumulative Energy Comparison (kWh)

Recovery Gain: 40.92%
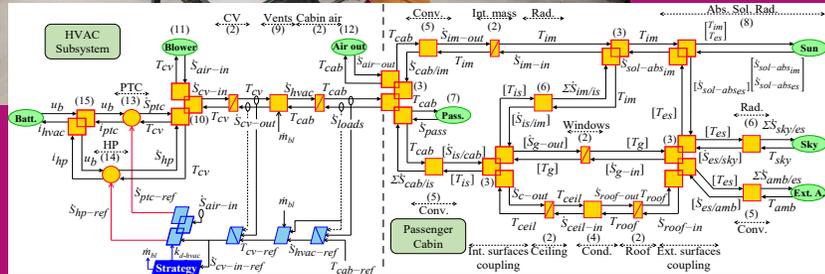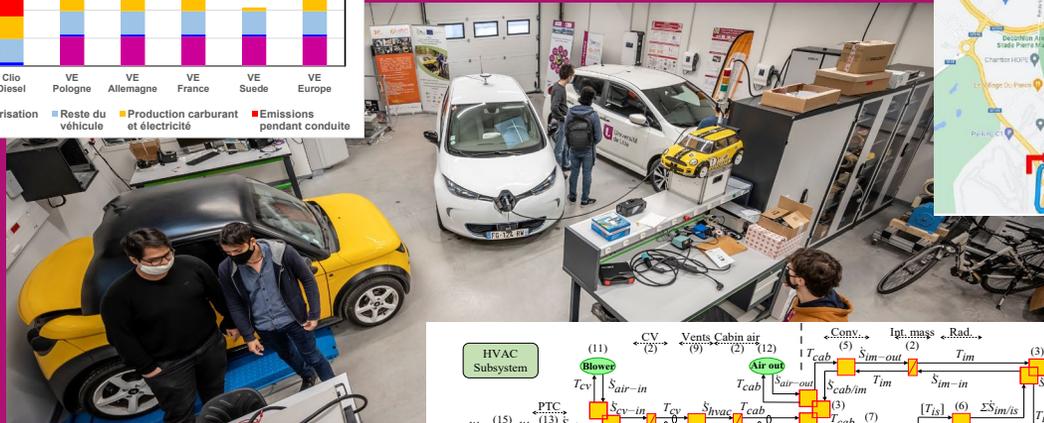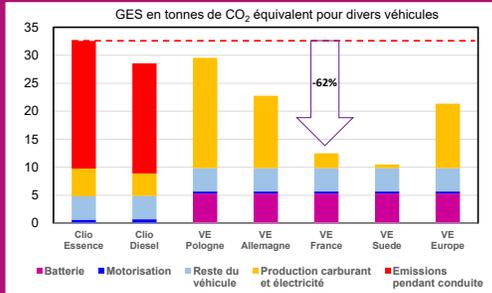
Conclusion & Outlook

✓ **Conclusion**

- Development of a Citadis X03.1 Simulation
- Comparing our simulation with Alstom's gives a 6% error,
- Simulating the energy consumption of a single tram using a cycle from GPS data shows a recovery potential of around 40%, highlighting the value of energy optimization.

✓ **Outlook**

- Validate our simulation model using experimental measurements.
- Simulate trams under real traffic conditions to analyze their energy consumption.
- What are the impacts of integrating an on-board energy storage system and station-based storage system?

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Thank you for your attention