

Final Event
24-25th of May 2022

Evaluation Group

Automatic Subway



Powerful **A**dvanced **N**-Level **D**igital **A**rchitecture
for models of electrified vehicles and their components

Ryan O. Berriel
Charles Brocart
Philippe Delarue
Alain Bouscayrol

Outline



-  **The European Metropole of Lille**
-  **MEL Subway System**
-  **Simulation results**
-  **Feedbacks**

The European Metropole of Lille



MEL – Presentation



The European Metropole of Lille is an urban authority:

- Intermunicipal public collaboration (1968)
- 95 cities / 1.2 million inhabitants / 672 km²
- 1.940 billion euros budget in 2022

>70% of expenses to **metropolitan policies**
(city policy, quality of life, transport, etc.)

20 essential and varied areas such as: economic, social and cultural development ; town planning; public spaces; **transport and mobility**; sport; protection and enhancement of environment and living policy; water and sewage; waste management; **energy...**



MEL – Sustainable development



- **MEL's policies aim at adapting to social changes:**
 - **Carbon neutrality** and **the fight against climate change** are among the **major challenges**
 - Urban adaptation to climate change: Water, Air and Soil Strategies
 - In February 2021, the MEL adopted its **Territorial Air Energy Climate Plan** (PCAET) to conduct the energy transition and to meet the challenge of climate change
 - **PCAET sets a course for 2030:** territorial objectives for reducing greenhouse gas emissions, energy consumption, the development of renewable energies, improving air quality and adapting to climate change
 - **Innovation and research** are priorities for the MEL in order **to develop a more sustainable metropolis**



MEL – Transports & mobility challenge



The MEL is the organizing authority for transport in the metropolis:

- Transport management of **5 million people every day**
- **ilévia** is the MEL's public transports network

*2 **metro** lines, 2 **tram** lines, 106 **bus lines** (428 bus CNG)*

VAL system: the first automatic subway line in the world in 1983

- In 2019, the MEL has adopted its **transport infrastructures masterplan** (SDIT) that proposes ambitious projects focused on mobility infrastructures up to 2035

a tool for the implementation of its environmental policy



The MEL develop electro-mobility:

- Deployment of charging stations for electric cars
- Projects on electric and hydrogen buses



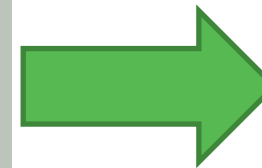
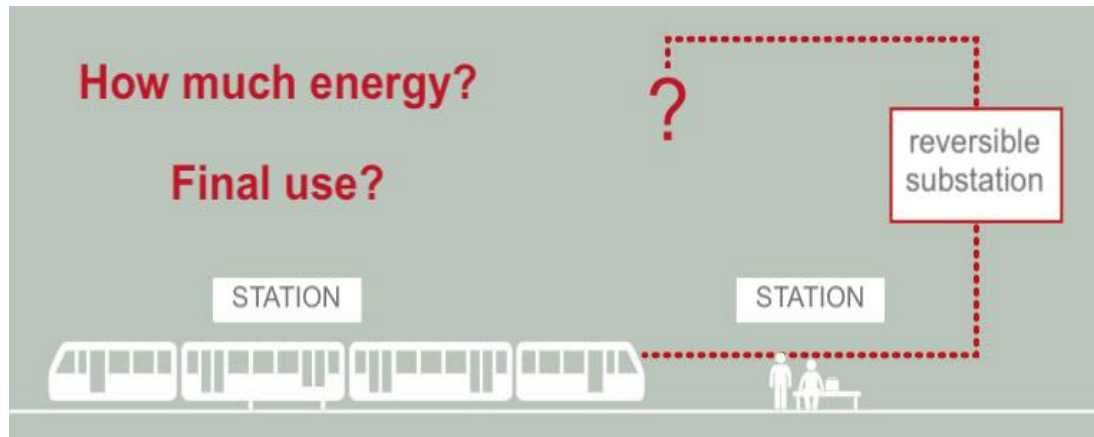
MEL Subway System

MEL – Subway braking energy recovery



A new subway

- retrofit and double the capacity of Line 1 of MEL
- **how to improve the energy efficiency of the subway system?**
- **Regenerative braking** as promising solution



**Energetic and flexible simulation
is essential**

- in **partnership between MEL and L2EP**



Vehicle Configuration



3 traction cars + 1 non-traction car

Traction car



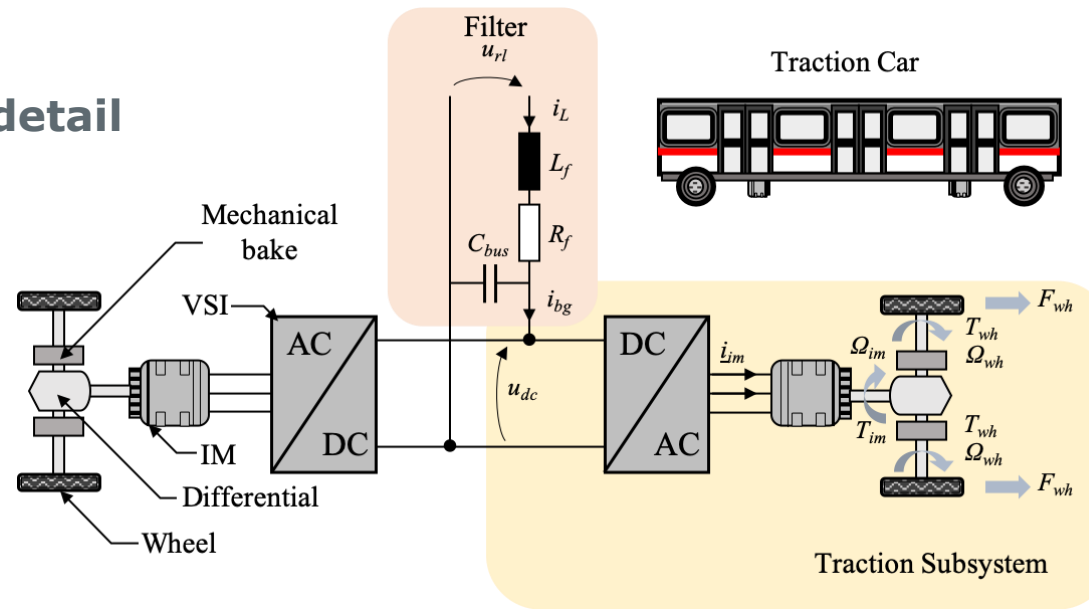
- 2 Bogies (Traction + braking)
- 2 induction machines

Non-traction car



- 2 Bogies (braking)

• Traction car detail

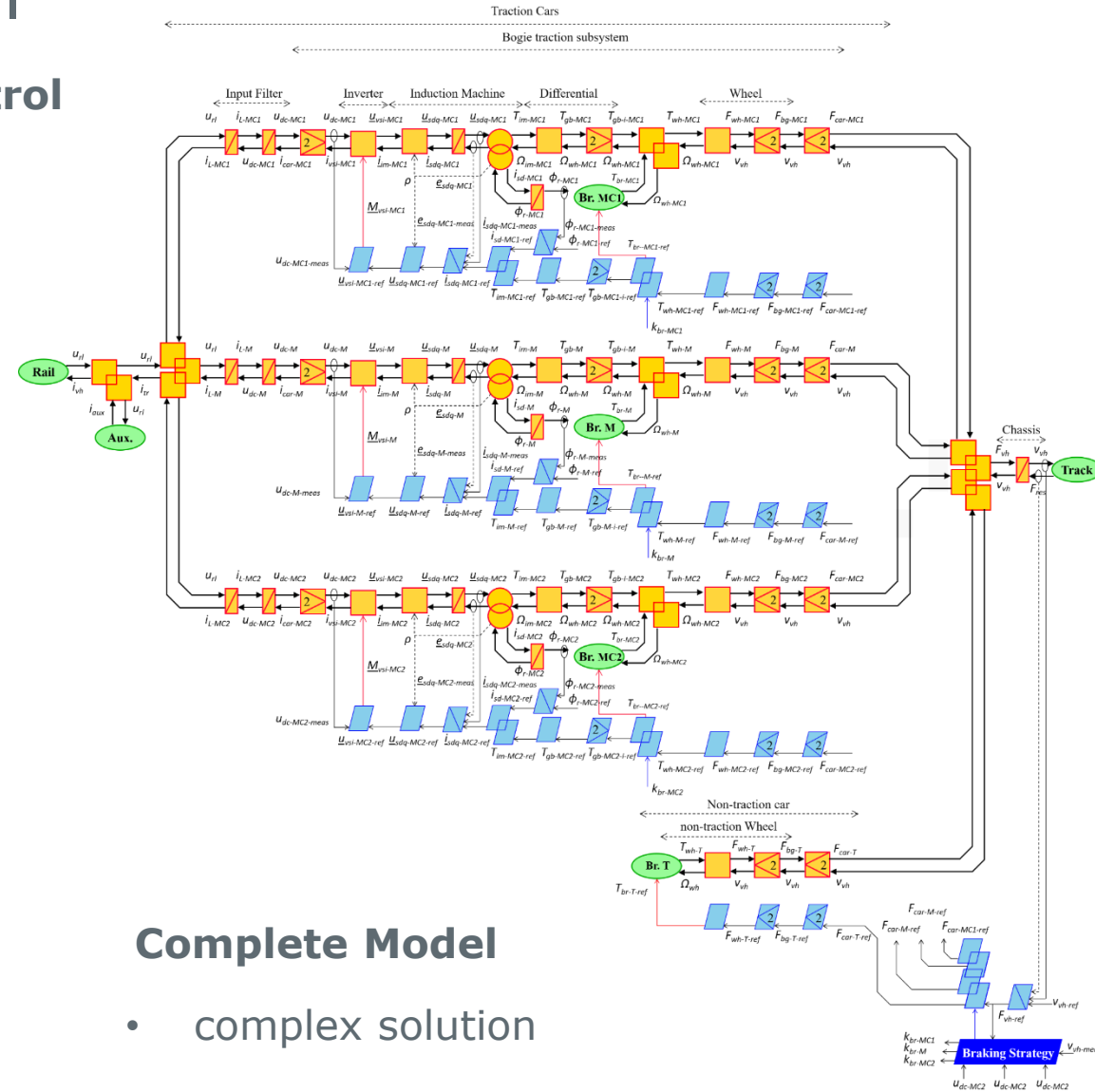
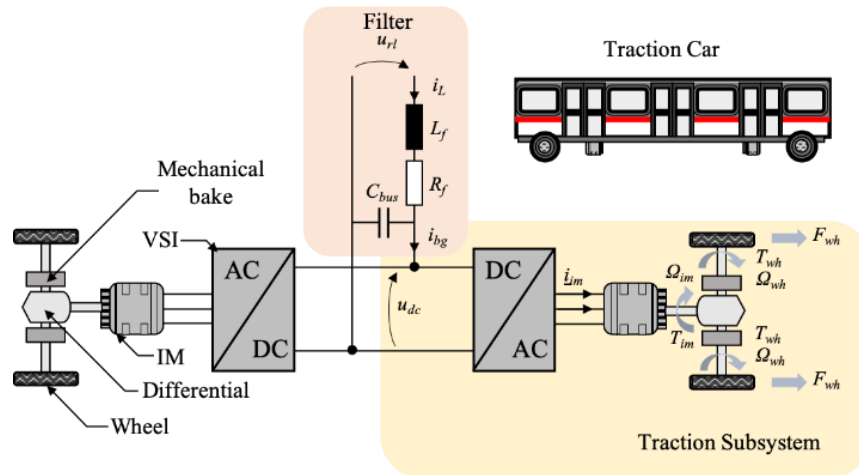


Subway Vehicle Model

EMR formalism -> Model and control



Traction Subsystem



Complete Model

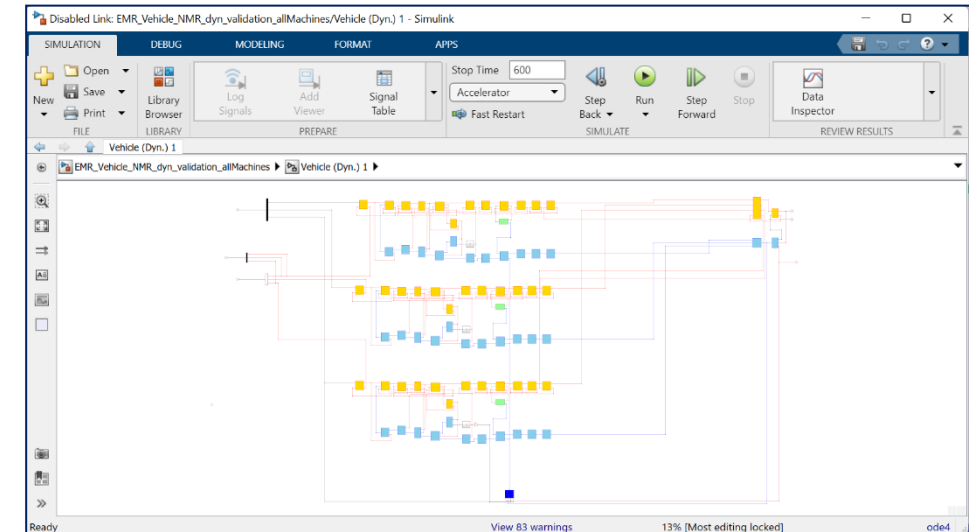
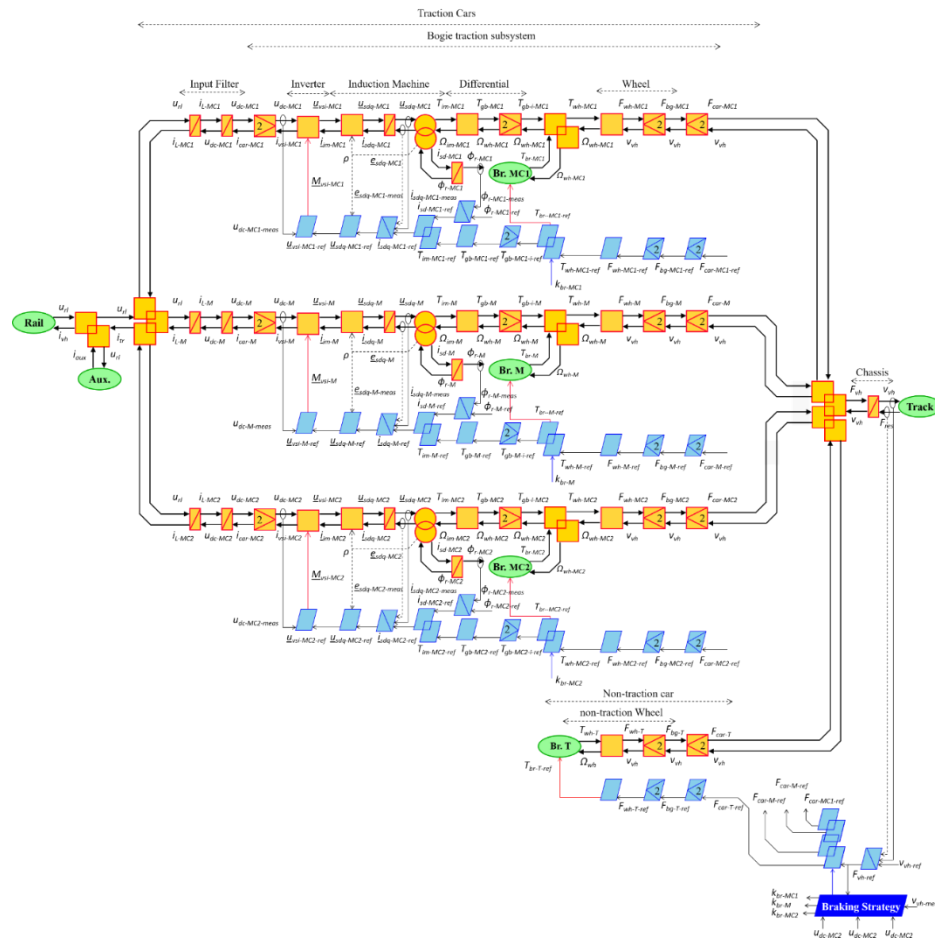
- complex solution

Simulation Tool

MATLAB Simulink ©



EMR-based model implemented in MATLAB- Simulink ©



Simulation tool



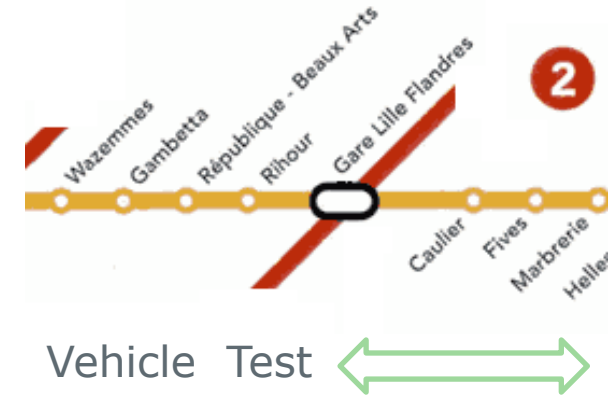
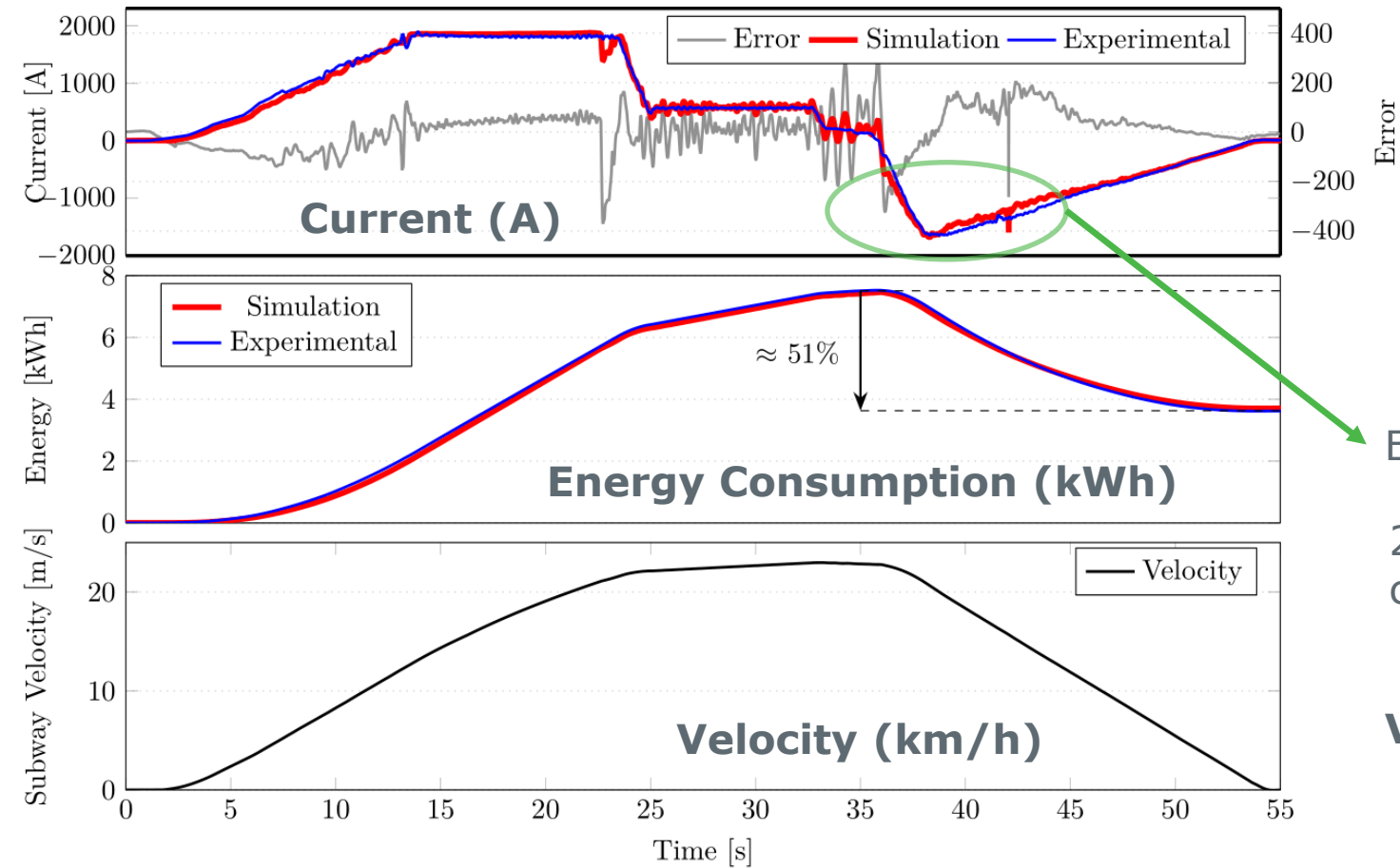
Model Validation



MÉTROPOLÉ
EUROPÉENNE DE LILLE



— Experimental
— Simulation



Energy recovery phase

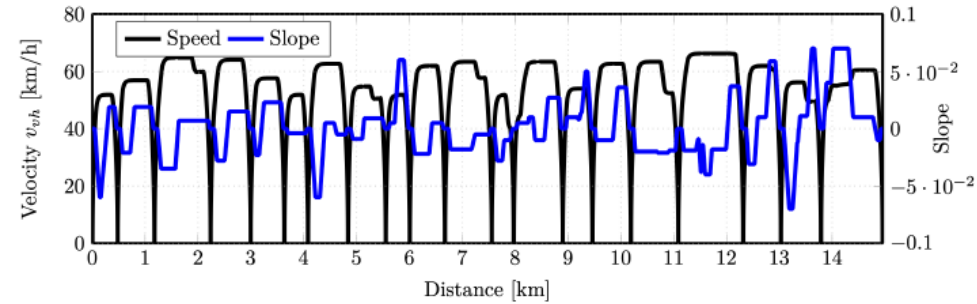
2.1% difference in energy consumption

Validation of the simulation tool

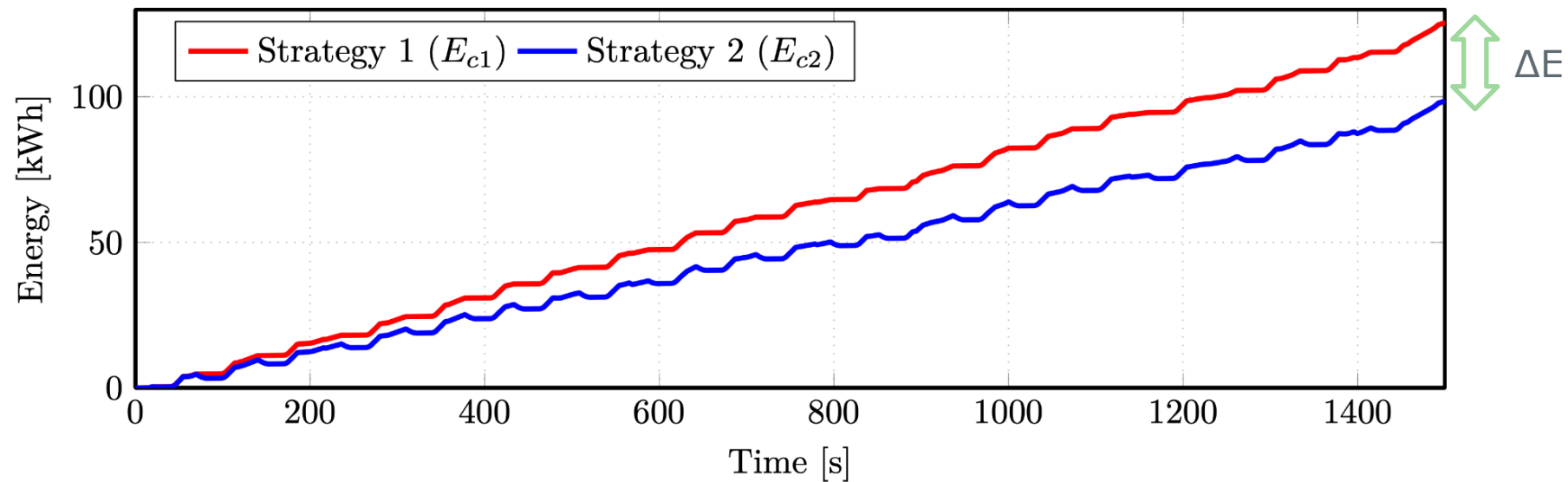
Simulation results

Extremes scenarios have been first studied

- Pure mechanical braking (Strategy 1)
- Full regenerative braking (Strategy 2)



21 Stations - 15km



21 % of energy at maximum can be saved for the considered trip



Conclusion



Feedbacks

- 🐼 EMR formalism: interest for organization of complex model and reliable results
- 🐼 EMR training: 1 month (no previous background on EMR)
- 🐼 Simulation development: about 4 months
- 🐼 Model validation: 1 week (tests already performed by Alstom for MEL)

Future steps (not in the evaluation group work)

- 🐼 Simulation of the subway carrousel (incl. supply station and rails)
- 🐼 Increase the recovery of braking energy
- 🐼 Reuse energy for EV charging station



Evaluation Group



In collaboration with



End of presentation

www.project-panda.eu



SIEMENS

