Emanuele Fedele

New generation of multimodal trains for eco-sustainable rail transport

Tutor: Prof. Diego Iannuzzi
co-Tutors: Prof. Andrea Del Pizzo
PhD. Ing. Luigi Fratelli (Hitachi Rail STS)

Cycle: XXXV

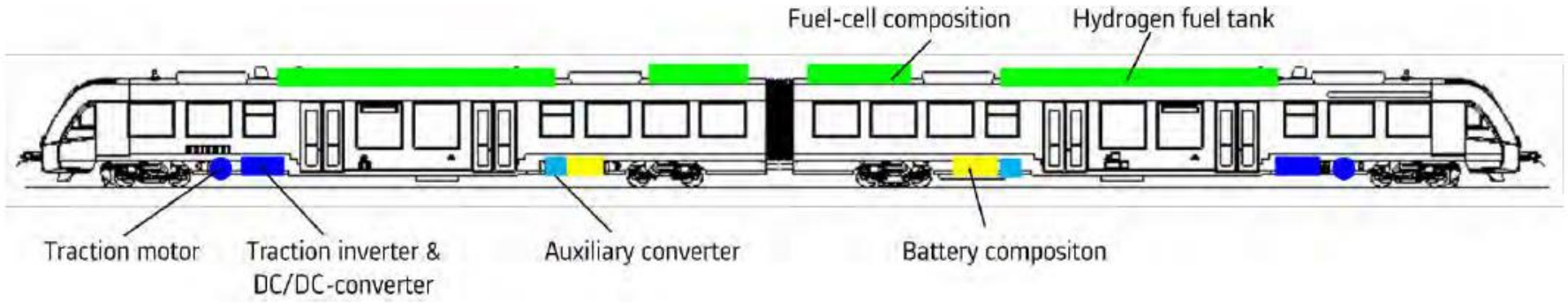
Year: 2020/2021

My background

- MSc in Electrical Engineering – Università degli Studi di Napoli "Federico II"
- Research group: Electrical Machines, Converters and Drives (ING-IND/32)
- PhD start date: 01/12/2019
- Scholarship type: MUR PON
- Partner company: Hitachi Rail STS S.p.A.

Research field of interest

My research field is related to traction systems of **rail vehicles** equipped with **alternative primary sources** and **onboard storage devices** for increased efficiency, lower emissions and potential wireless operation.



Summary of study activities

- Courses, PhD schools, Tutorials

Statistical Data Analysis for Science and Engineering, by Prof. Pietrantuono, ad hoc PhD course;

Programming and Visualization with Python, by Prof. Botta, ad hoc PhD course;

Reti Elettriche Complesse e Simulazione Circuitale, by Prof. De Magistris, borrowed my DIETI M.Sc. Curricula.

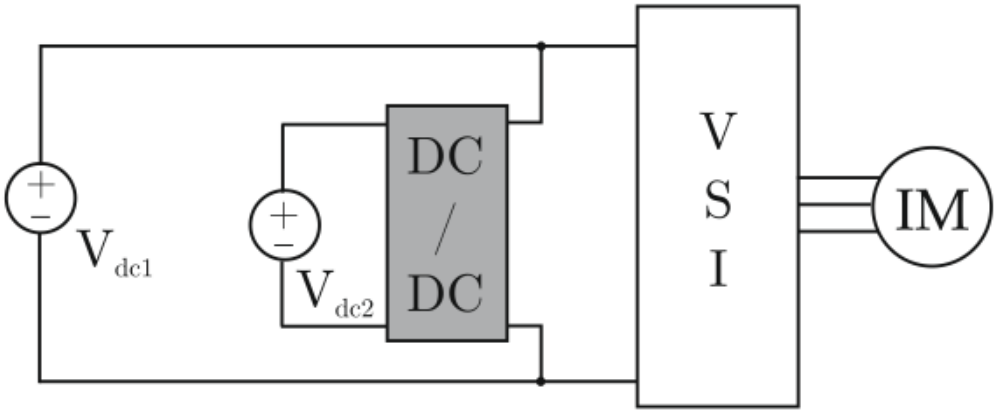
European PhD School on Power Electronics, Electrical Machines, Energy Control and Drives, organized by Università di Cassino, European Center for Power Electronics, and Associazione Nazionale Azionamenti Elettrici.

Passives in Power Electronics: Magnetic Components Design and Simulation, online tutorial organized by European Center for Power Electronics

Research activity: overview

- Problem

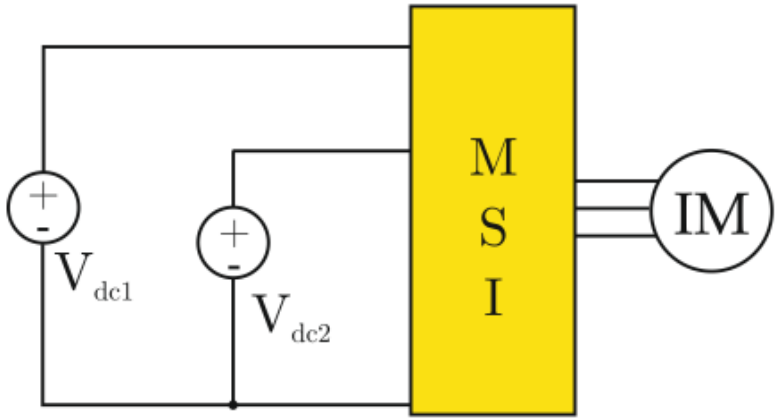
Multimode rail vehicles enable higher efficiencies, lower emissions and wireless capability. However, they need power-electronics-intensive architecture, with at least one **bulky and expensive DC/DC converter** sized for peak power demands. A more compact alternative would be attractive for manufacturers.



Research activity: overview

- Objective

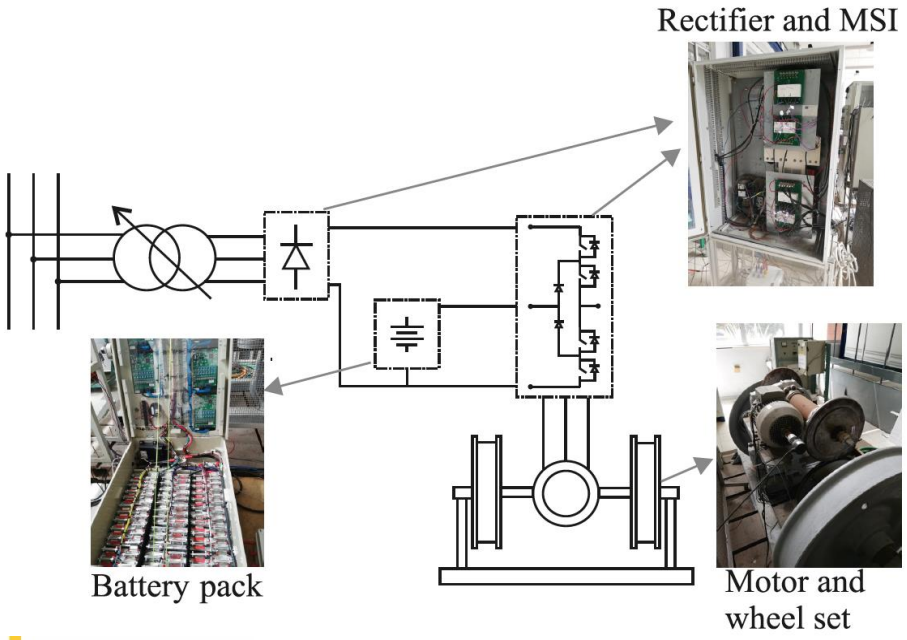
The size **reduction or complete elimination of DC/DC converters** could be achieved by proper integration and control of the **Multi-Source Inverter (MSI)** as main traction converter. The research objective for this 2nd year was the development of a novel modulation strategy to allow the MSI for full control of the charging and discharging of DC sources while properly supplying the traction motor.

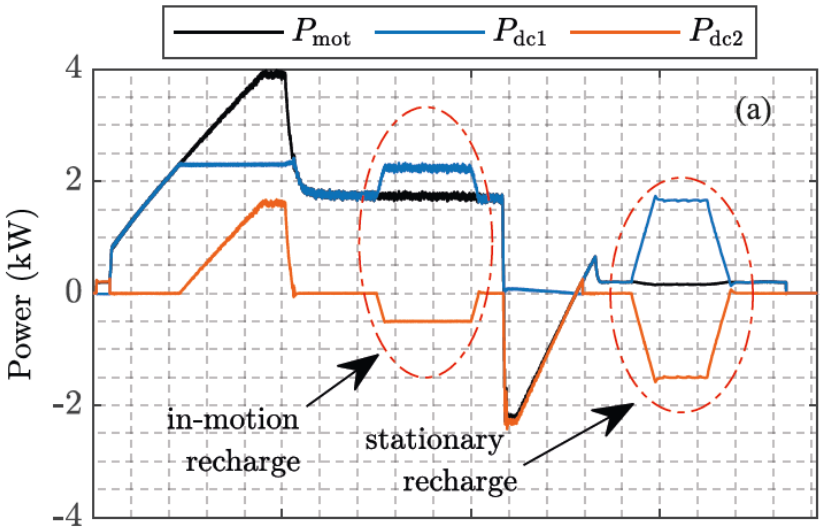


Research activity: overview

- Methodology and preliminary results

The proposed control for MSI-based systems was successfully validated by means of **numerical simulations** and **experimental tests** on small-scale rail simulators.





Products

[J1]	E. Fedele, D. Iannuzzi, and A. Del Pizzo: ‘‘Onboard energy storage in rail transport: Review of real applications and techno-economic assessments’’, IET Electrical Systems in Transportation (early access version), 2021.
[J2]	E. Fedele, D. Iannuzzi, P. Tricoli, and A. Del Pizzo: ‘‘Characterisation of the Multi-Source Inverter for Multimode Rail Traction Systems’’, submitted to IEEE Trans. on Vehicular Technology, currently under review.

Next year

Quantify the potential techno-economic benefits brought by the MSI-based traction architectures for bimodal light rail vehicles, with focus on DC/DC converter power size, device count, possibly volumes and costs, overall efficiency. Simulations and experimental tests will be performed to this aim.