

PhD presentation XXXV cycle 2019/2020

Hadi Rahmeh

September 24, 2020



POLITECNICO
DI TORINO

Mechatronics Lab

- Name and Surname: **Hadi RAHMEH**
- Tutor: **Nicola AMATI**
- Scholarship: **Ateneo**
- Main research theme: **Modelling, design and control of Hybrid Electric Vehicles P2 HEVs**



- Collaborations:

1. **Dayco Europe S.r.l.**

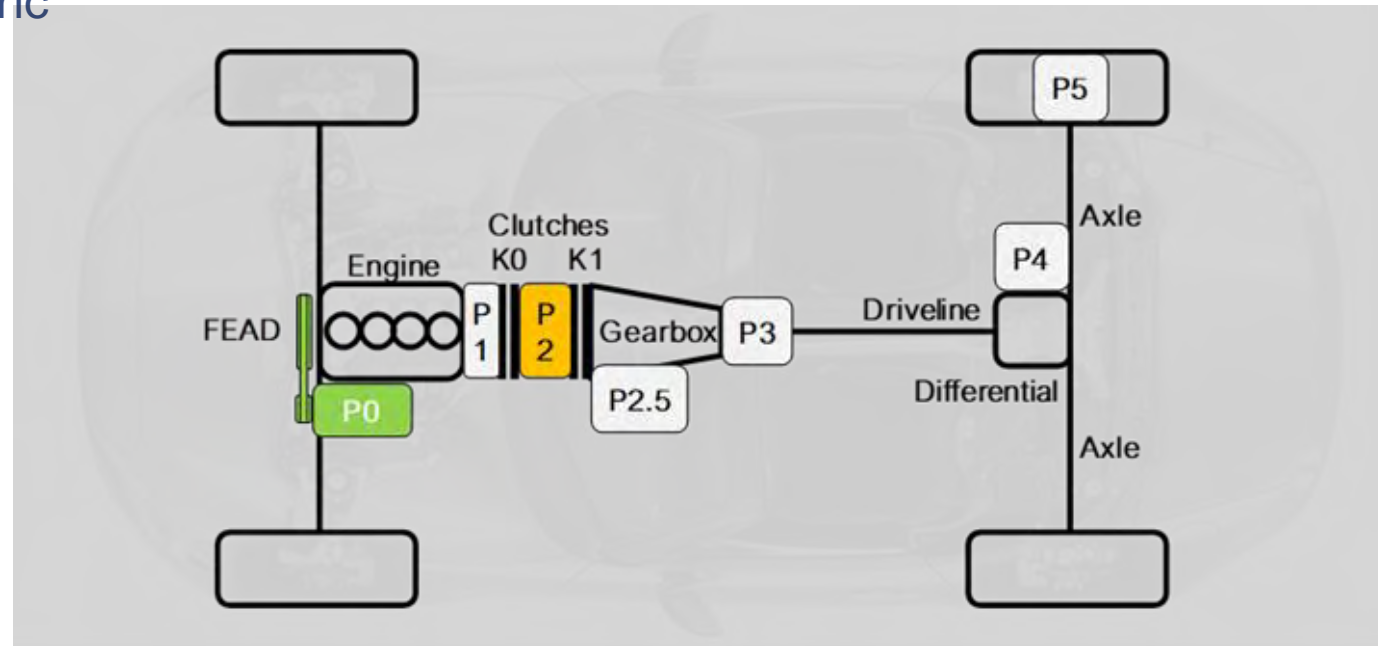


MOVE FORWARD. ALWAYS.™

2. **Wave for Energy S.r.l.**

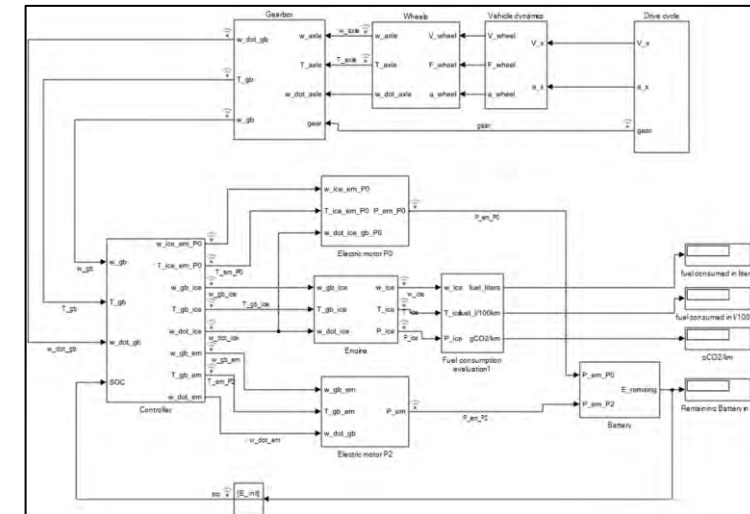
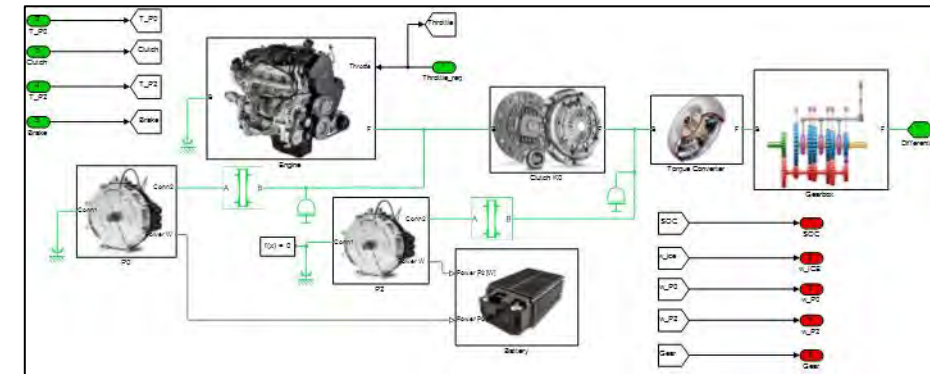
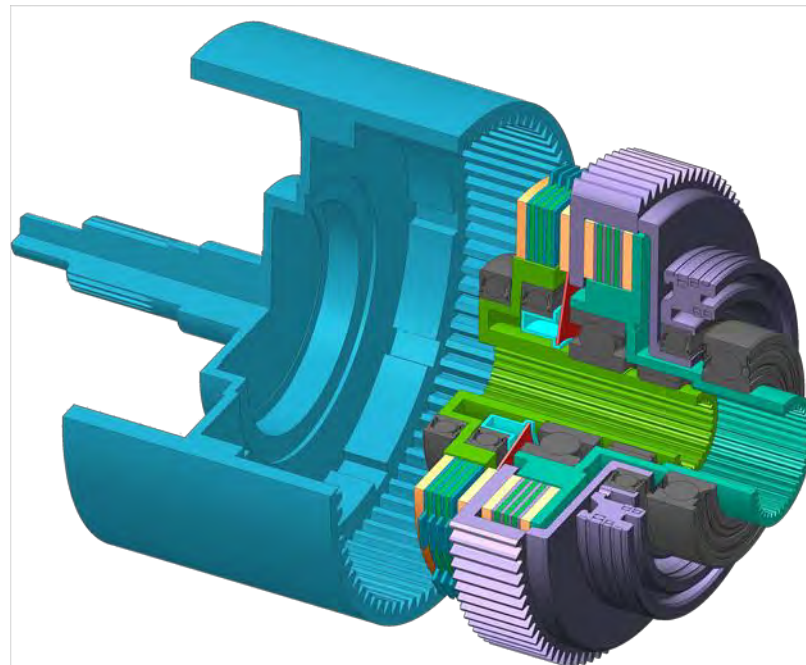
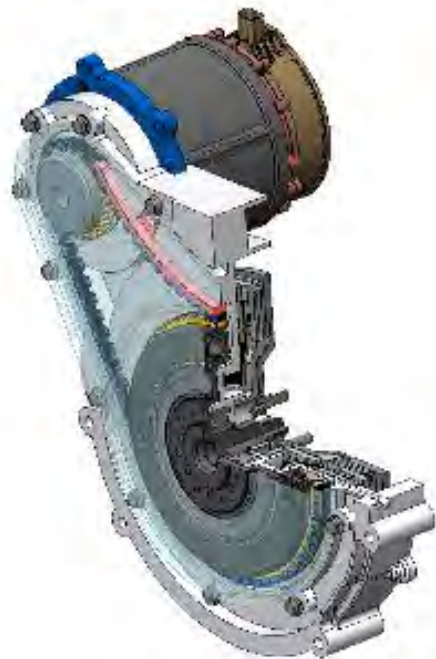


- The research activity was centered around the Hybrid Electric P2 vehicle architecture.
- In the hybrid electric P2 configuration the electric machine is placed on the input shaft of the transmission.
- The P2 configuration offers the following advantages:
 - + The electric machine can be disconnected from the engine, increasing the efficiency during recuperation by eliminating the ICE parasitic losses.
 - + Disconnecting the engine allows all electric drive.
 - Greater implementation costs with respect to P0 architecture.
 - The transmission efficiency causes additional losses compared to P3 or P4 architectures



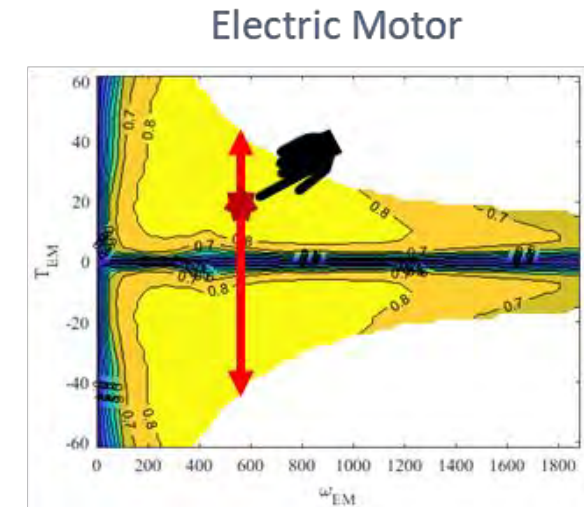
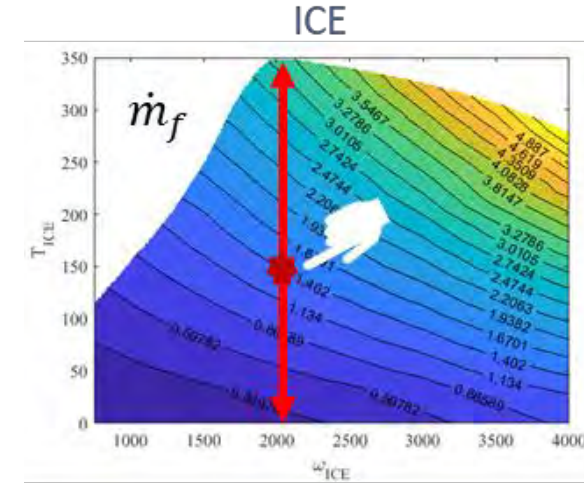
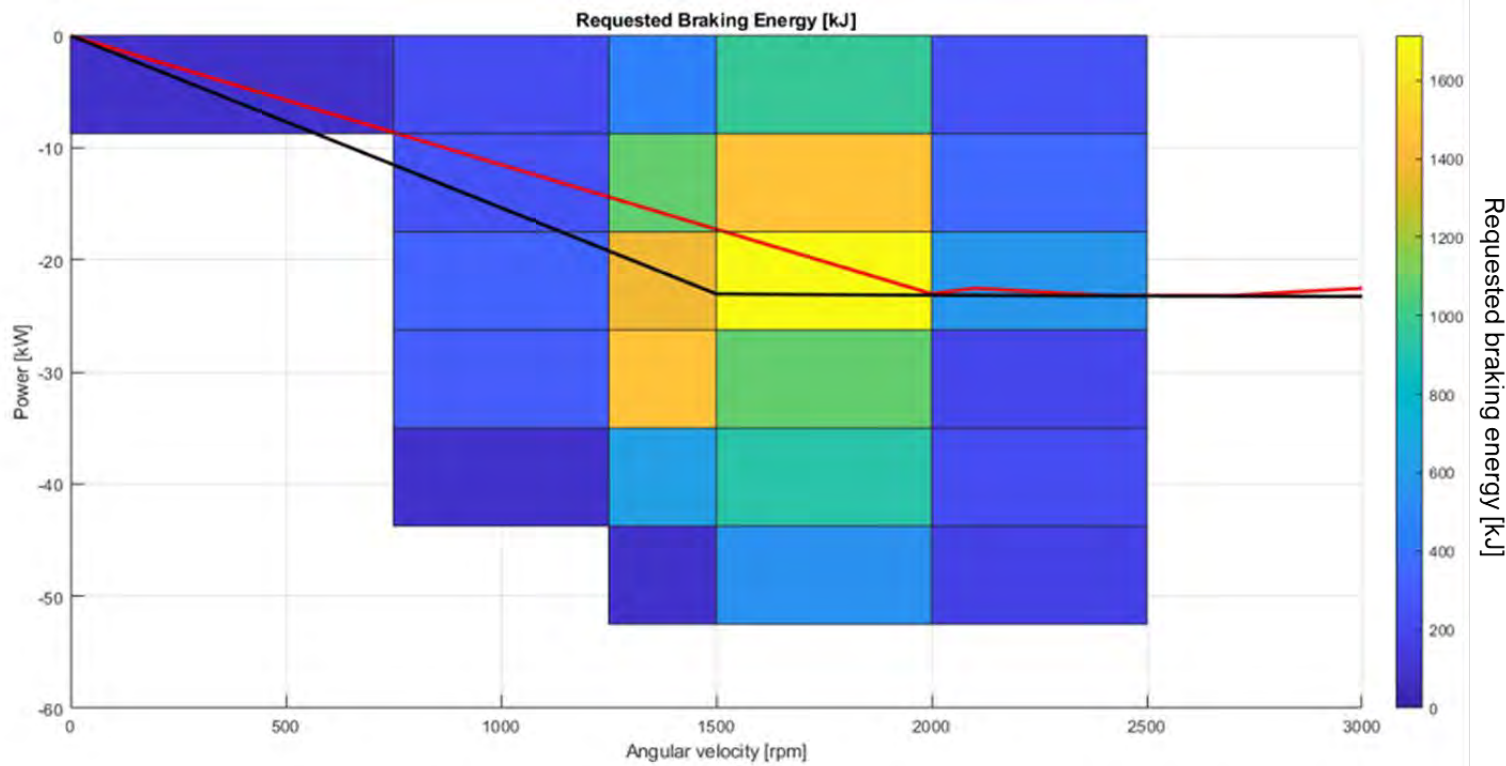
XXXV PhD Cycle – 2019/2020 – HEV P2 – Research approach

- The research work carried out so far includes:
 1. Development and analysis of both forward and backward models of P2 vehicles with the use of Simulink software.
 2. Analysis of off-axis and on axis P2 configurations.



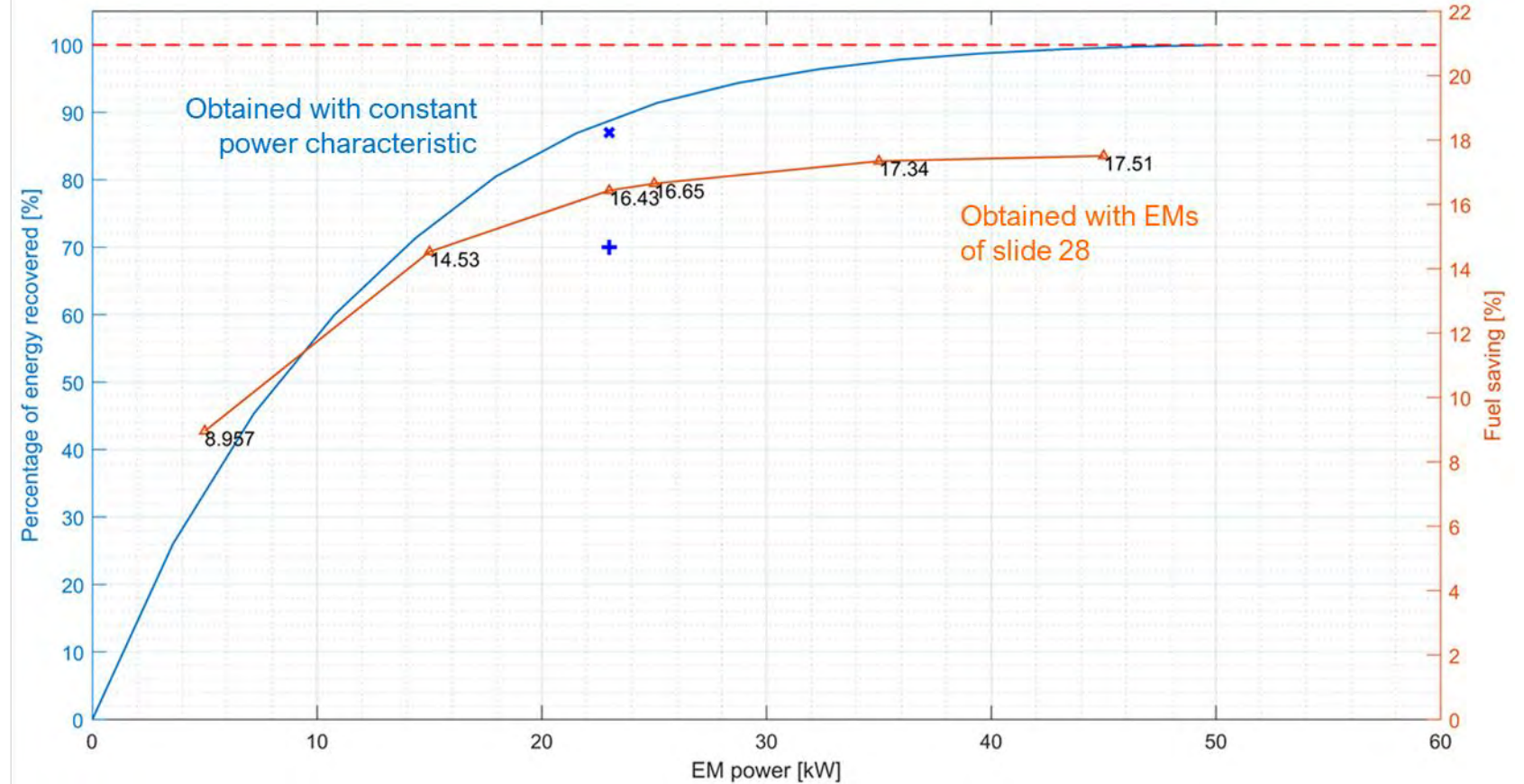
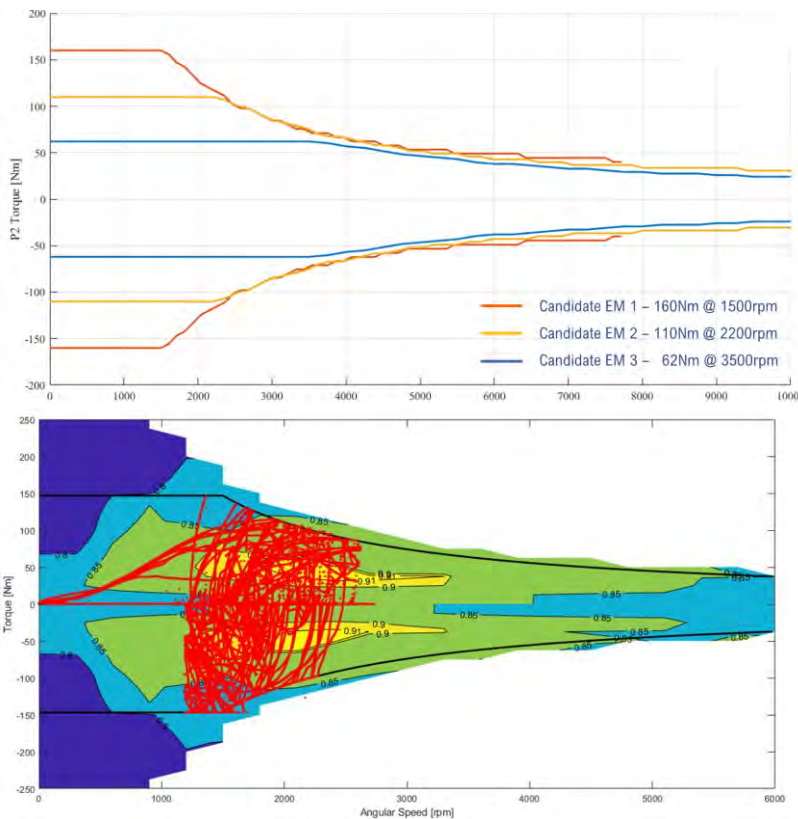
XXXV PhD Cycle – 2019/2020 – HEV P2 – Research approach

- The research work carried out so far includes:
 - Development of several power management strategies (Rule based, ECMS, Dynamic optimization, Fuzzy logic)
 - Study of braking energy recuperation in a P2 configuration.



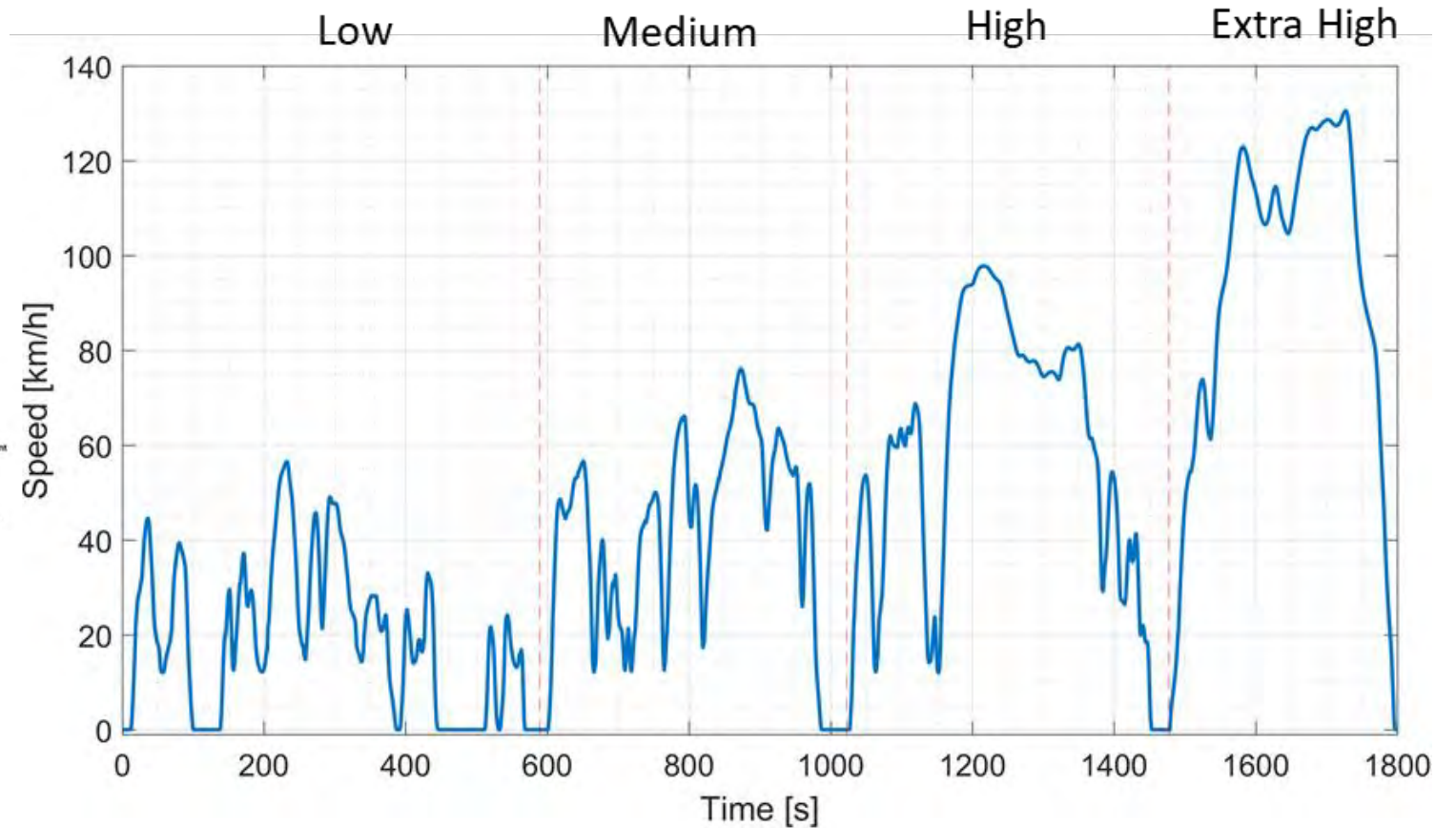
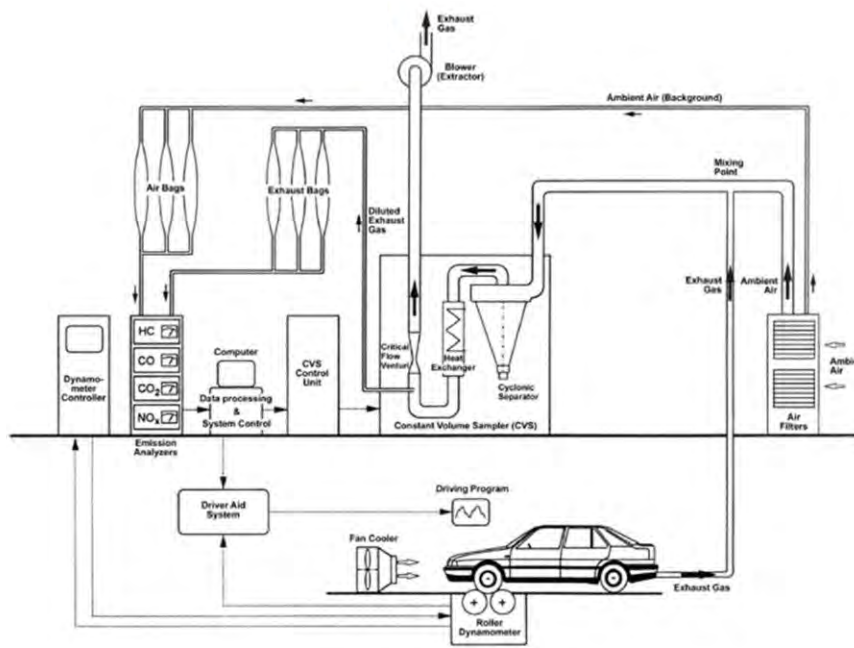
XXXV PhD Cycle – 2019/2020 – HEV P2 – Research approach

- The research work carried out so far includes:
 - Electric machine sizing for emissions reduction



XXXV PhD Cycle – 2019/2020 – HEV P2 – Research approach

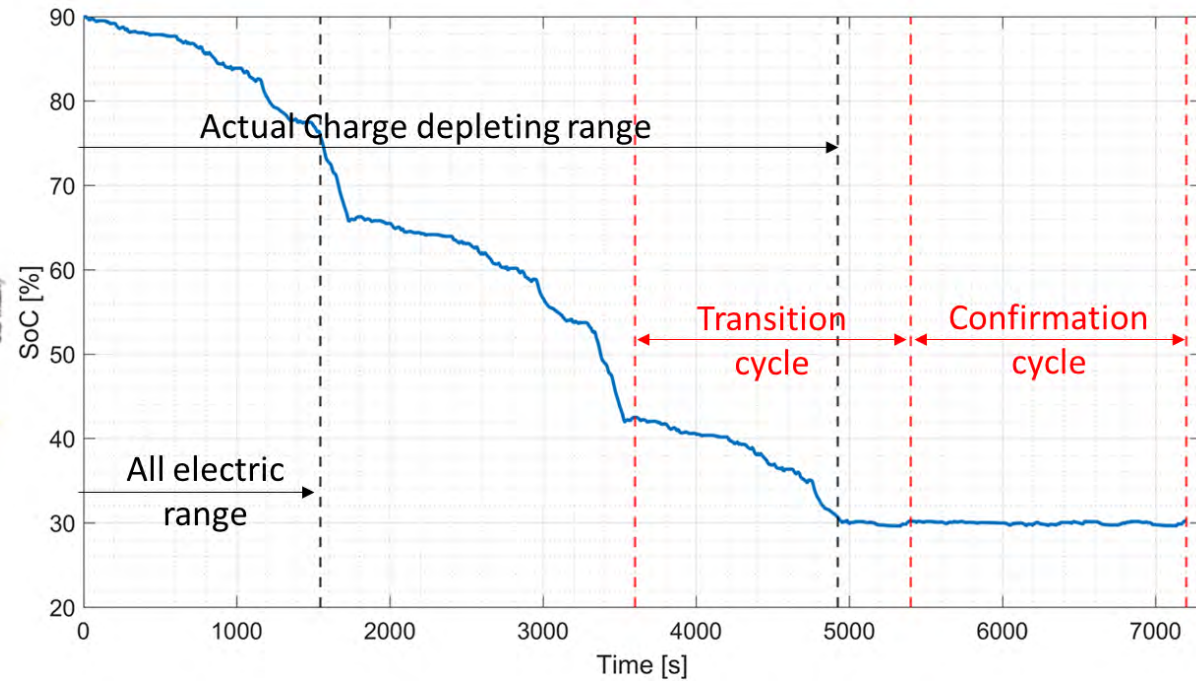
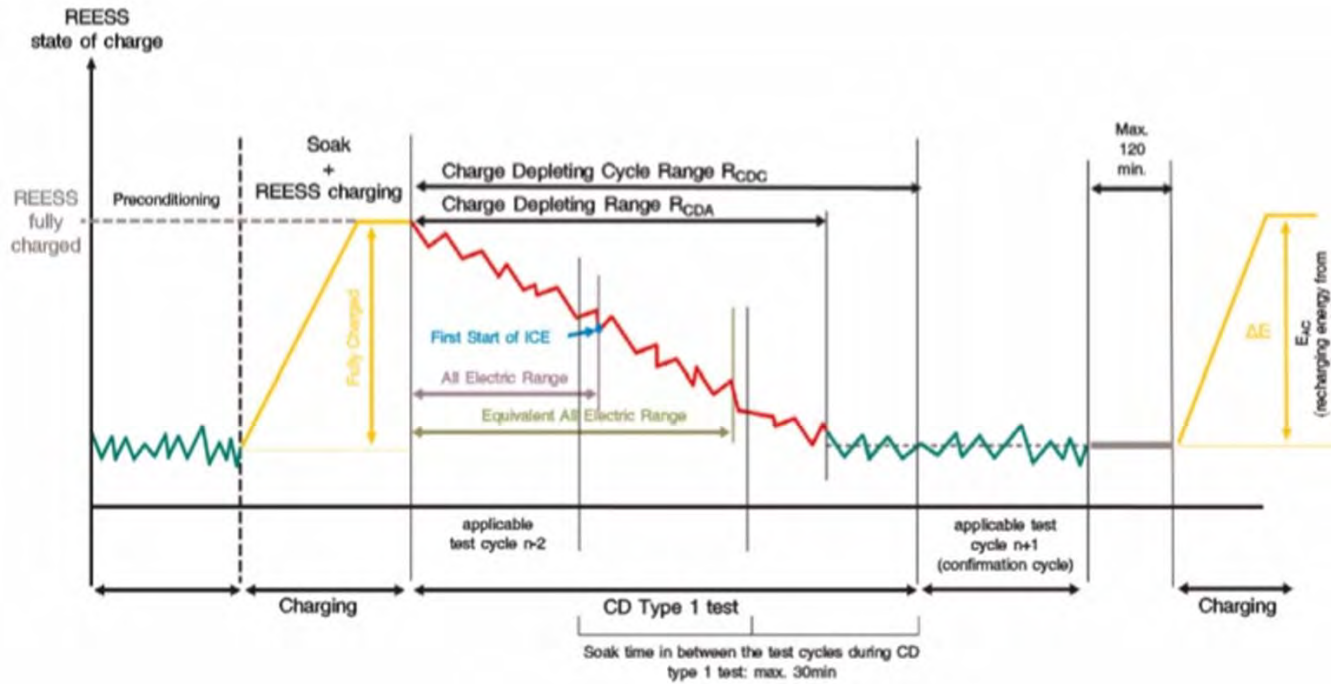
- The research work carried out so far includes:
 - Study of the WLTP regulation for estimating HEV emissions, in addition to WLTP regulations training provided by Dayco.



XXXV PhD Cycle – 2019/2020 – HEV P2 – Research approach

- The research work carried out so far includes:

- Analysis of a P2 High voltage configuration and battery sizing in order to reduce CO2 emissions calculated according to WLTP regulations

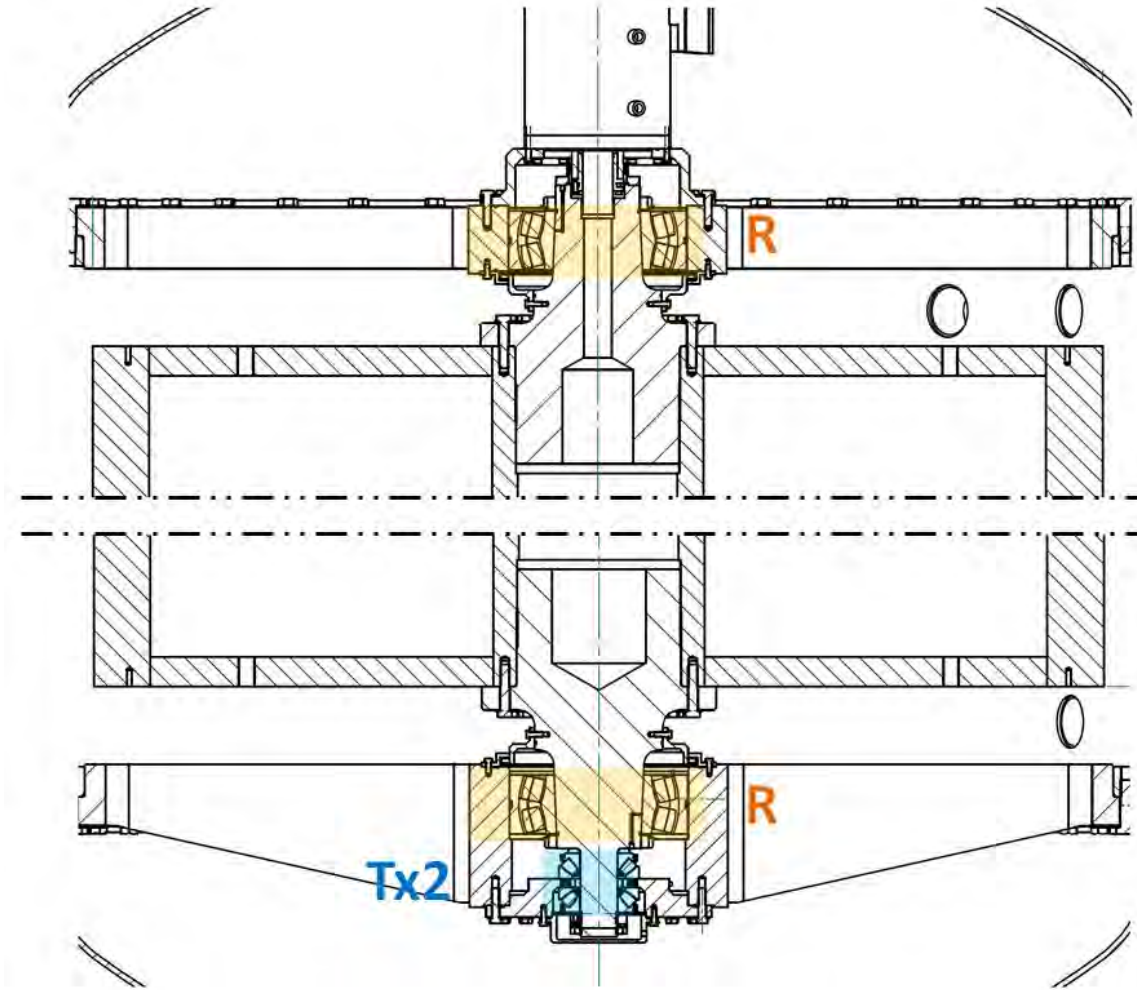
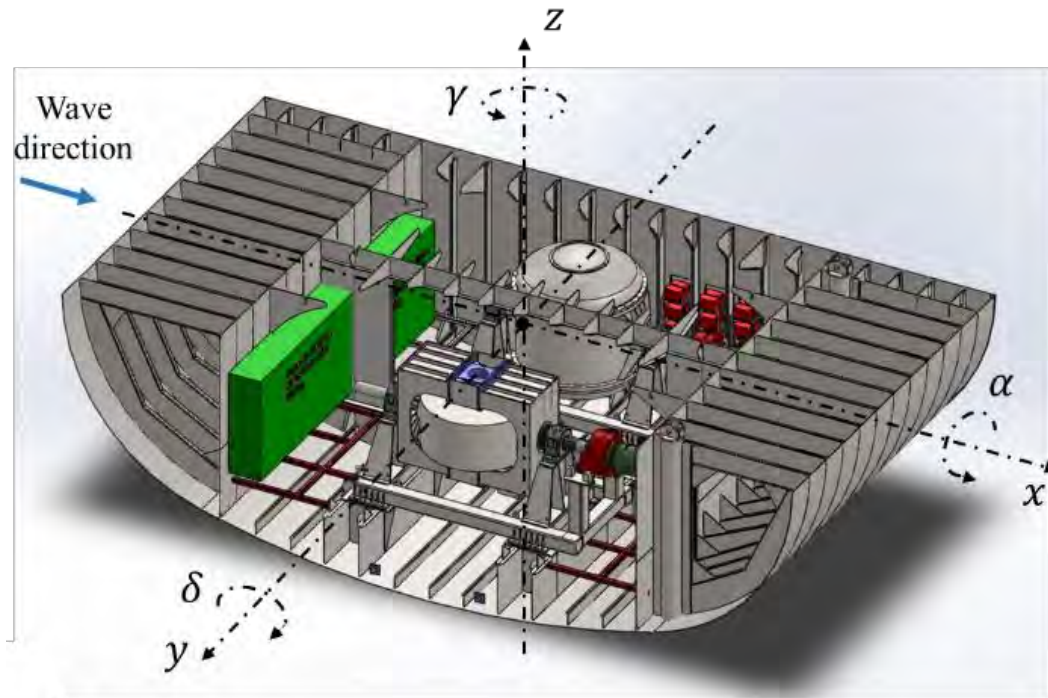


- Prototype validation
- Testing on a test bench consisting of a partial vehicle: ICE, EM and the accessories needed to run the setup
- On vehicle testing using a roller bench.



XXXV PhD Cycle – 2019/2020 – Additional research activity – ISWEC

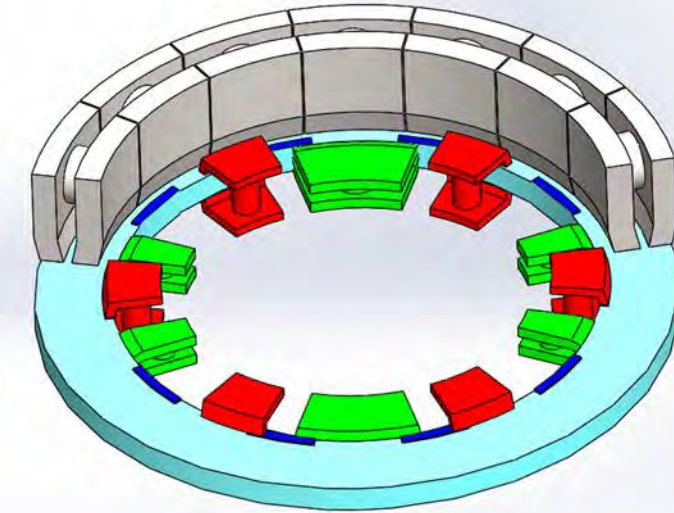
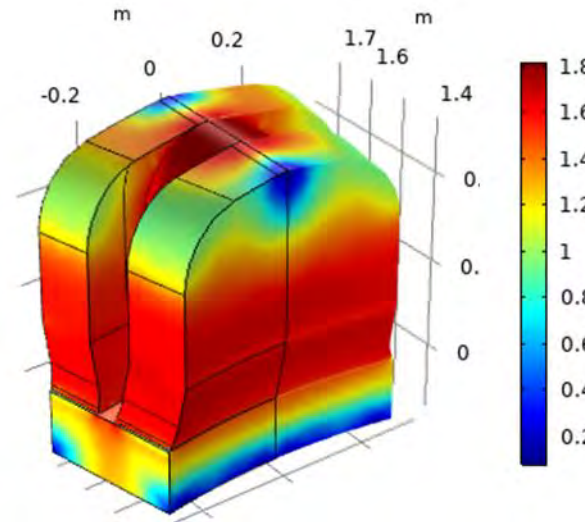
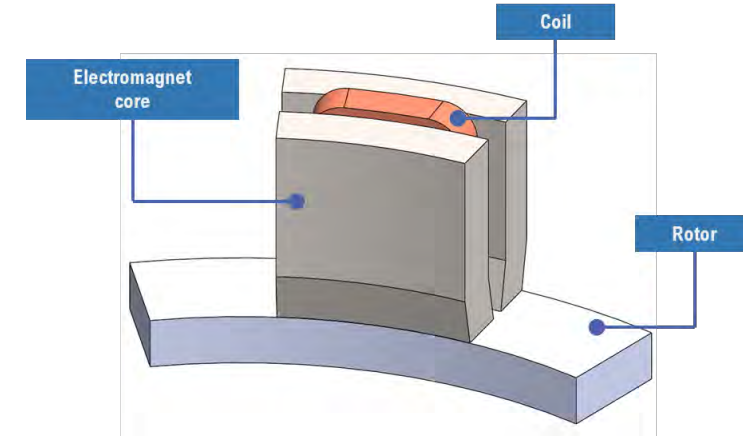
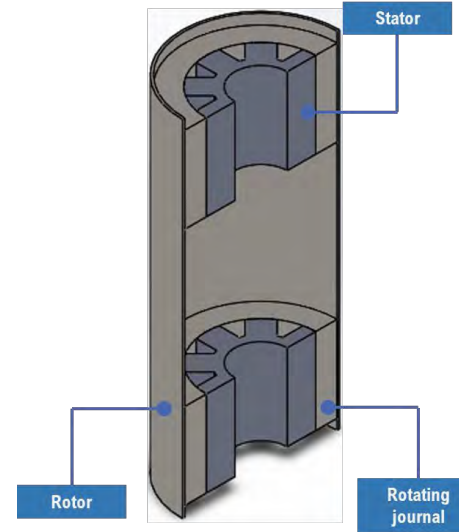
- Additional research activity involved the design of axial and radial active electromagnetic bearings AMBs for the rotor of the inertial sea wave energy converter ISWEC.
- The current rotor is supported on conventional bearings.
- By using electromagnetic suspension, the efficiency and energy output of the system can be increased.



XXXV PhD Cycle – 2019/2020 – Additional research activity – ISWEC

- The research activity involved:
 1. Evaluation of different layouts
 2. Analysis of the number of rotors
 3. FEM analysis using Comsol Multiphysics
 4. Analysis of the effect of the material selection
 5. Dimensions and geometry optimization
 6. Losses and efficiency evaluation
 7. Radial bearing design
 8. Switched reluctance motor design
 9. Magnetic coupling analysis

- Future work will include:
 1. Control design
 2. Rotor dynamic analysis
 3. Support structure design
 4. Prototype construction



- Courses completed during the year:
 1. 01UJJRO – Automotive transmissions (manual, non-manual and hybrid) (20h – III level course, hard skills, Politecnico di Torino)
 2. 01TAJRO – Servosystems: Characteristics, analytical tools and application to a use case: aircraft flight controls (24h – III level course, hard skills, Politecnico di Torino)
 3. 01IHENE – Trazione elettrica (60h – II level course, hard skills, Politecnico di Torino)
 4. 01QORRO – Writing Scientific Papers in English (15h – soft skills, Politecnico di Torino)
 5. Simdrive training from DAYCO (20 hours, Online training on Microsoft teams)
 6. WLTP cycles training from DAYCO, Prof. F Cavallino (16 hours, Online training on Microsoft teams)
- Publications:
 1. Rahmeh H., Bonfitto A., Ruzimov S. (2020, August). " Fuzzy Logic vs Equivalent Consumption Minimization Strategy for Energy Management in P2 Hybrid Electric Vehicles". In Proceedings of the ASME 2020 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (IDETC-CIE 2020), 22nd International Conference on Advanced Vehicle Technologies (AVT). (IDETC2020-22431).

Thank you for your Attention!

