DIN - DEPARTMENT OF INDUSTRIAL ENGINEERING

PhD Course in Mechanics and Advanced Engineering Sciences (DIMSAI)

PHD STUDENT POSTER - AY *2016/2017* Curriculum number *2* Cycle *XXXI*

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Powertrain Architectures and Technologies for New Emission and Fuel Consumption Standards

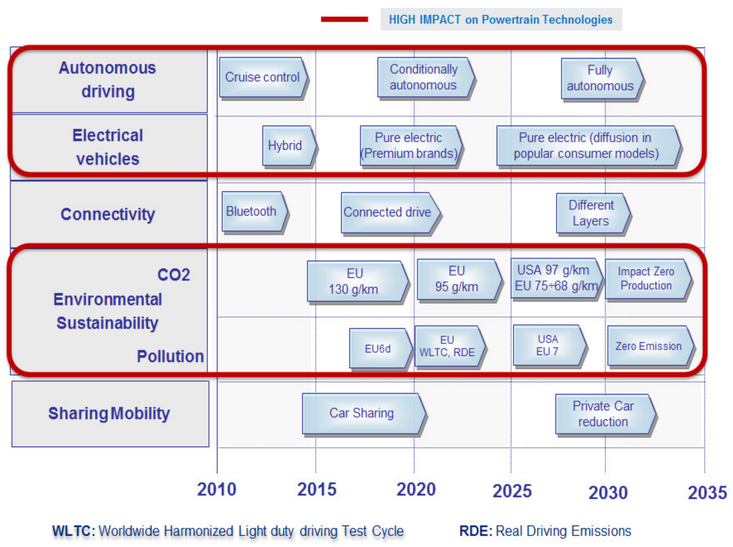

Fig.1 Automotive technology macro-trends

MOTIVATIONS

- The **macro-trends** that are shaping the evolution of powertrain technologies are:
  - sustainability, the simultaneous reduction of **CO_2/ fuel consumption** and **emissions**
  - **autonomous** driving
  - powertrain **electrification**
- The evaluation of a **powertrain solutions has to take into account** at the same time the **end-user requirements** and **the sustainability constraints,** that should be evaluated in term of Life Cycle

AIMS

- The **conceptual comparison among the most promising powertrain architectures and technologies**, considering their effectiveness, technological maturity and the impact on production costs
- The definition of a **structured methodology to link constraints** and **end-user requirements to powertrain technical features** and to **perform an objective comparison** of architectures and technologies

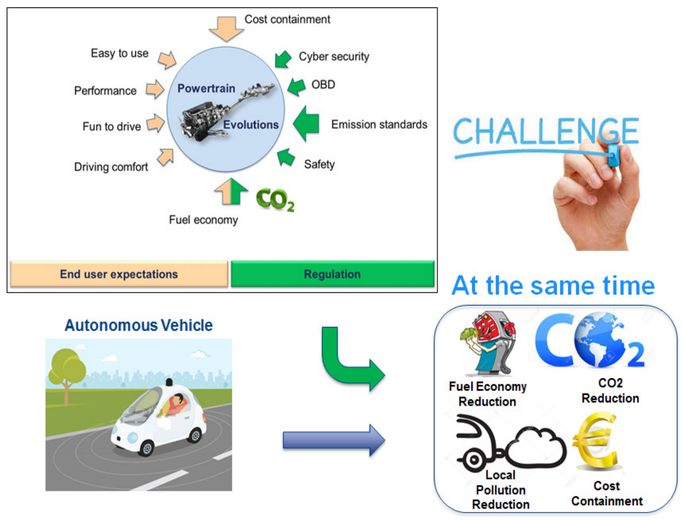

Fig.2 Powertrain design challenges

- Through the **multi-level Quality Function Deployment** method, the **needs by the users** and the **legislation constraints** are propagated **from the vehicle level to the powertrain level**

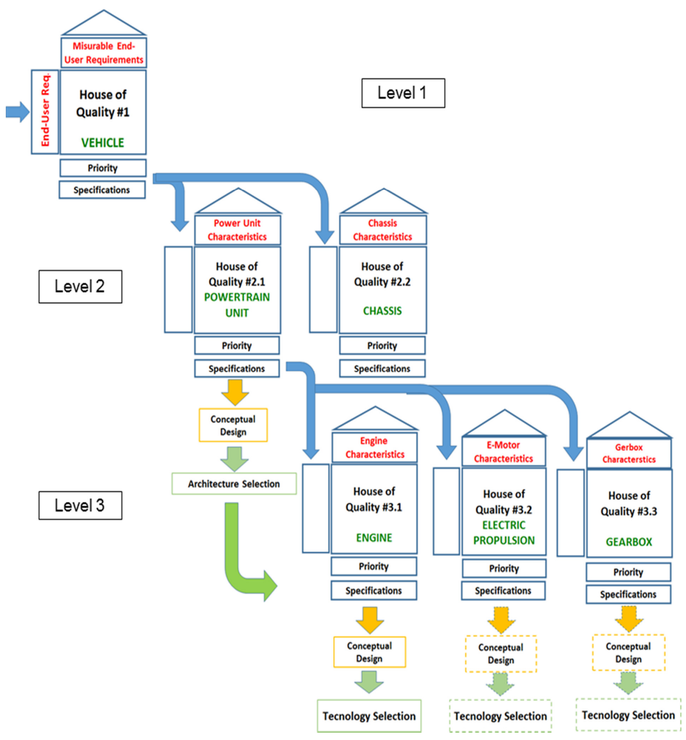

Fig. 3 Multi-level QFD

- **The analysis is carried out on the basis of technical literature**, integrating missing data by means **of powertrain and vehicle simplified models**

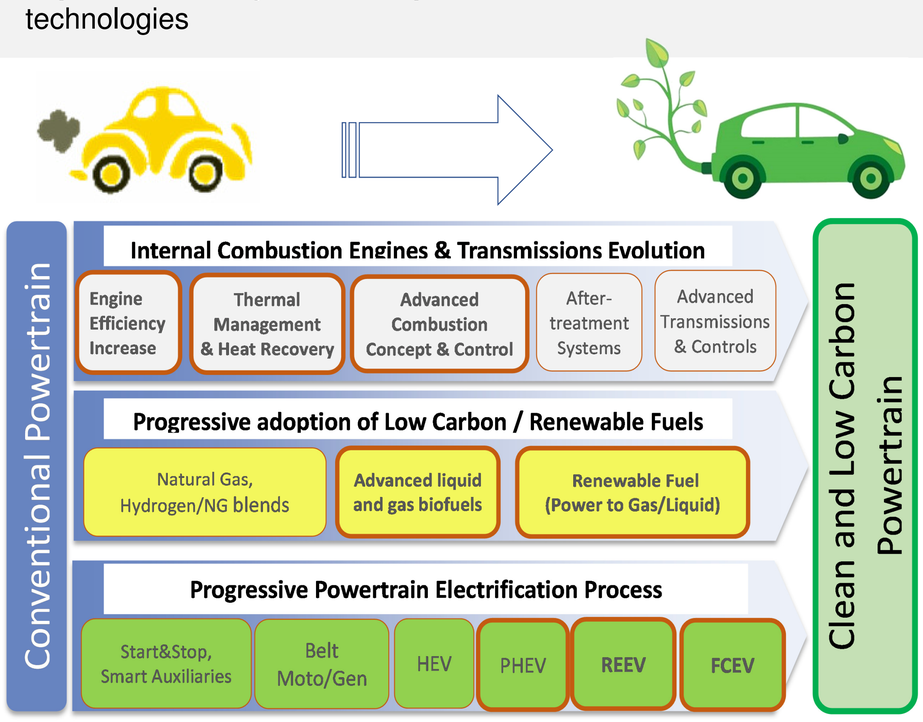

Fig. 4 Technology options for Powertrain improvement

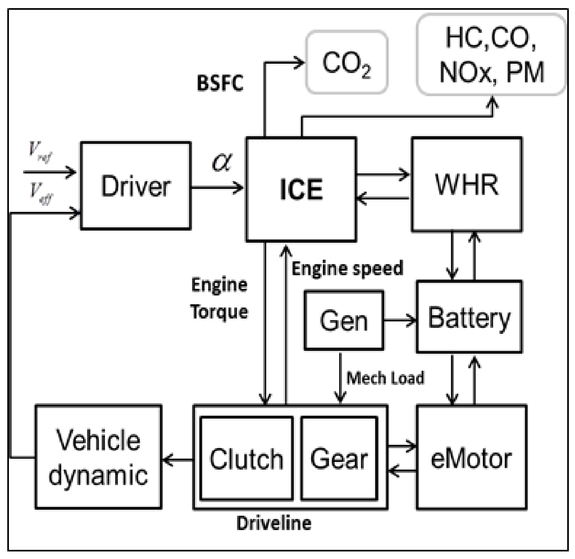

Fig. 5 0-D Powertrain and vehicle models

MAIN RESULTS

- Possible **technological paths for CO2 requirements** of C-Vehicles **up to 2025**, **without any performance and emission penalty**

- **The increasing of electrification** degree in powertrain architectures **enhances the requirement fulfillment**, due to ICE operation in highly efficient areas

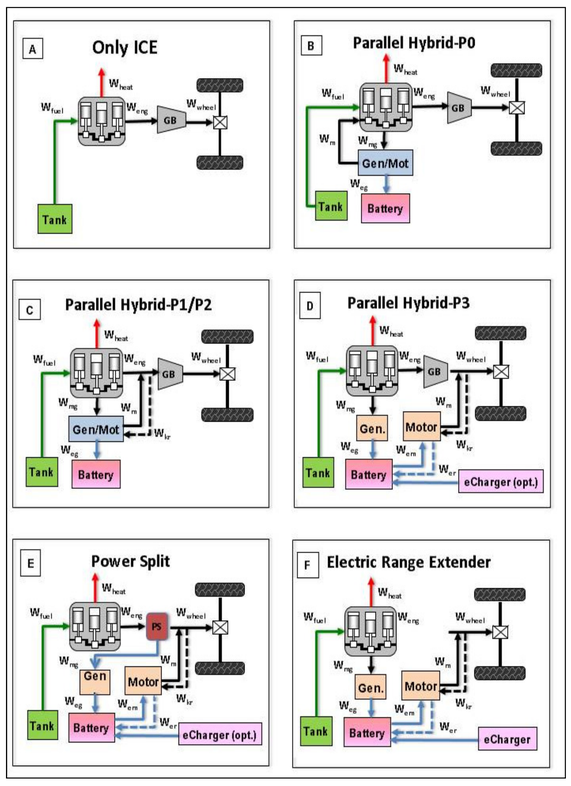

Fig.6 PWT architectures with different electrification degree

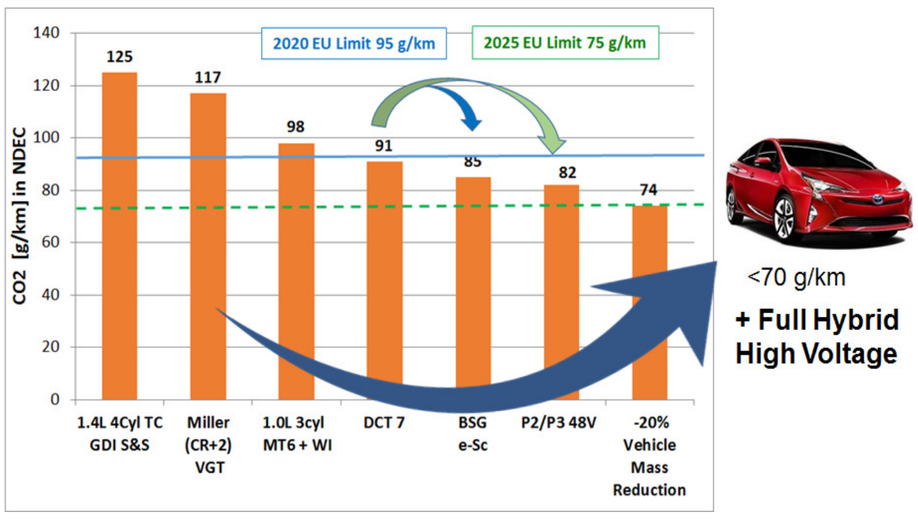

Fig. 7 Technology paths for CO2 reduction of C-Vehicle with SI engine

- The **key technologies to improve ICE** efficiency and emissions are : **Water Injection**, **Low Temperature Combustion** and **Engine Heat Recovery**

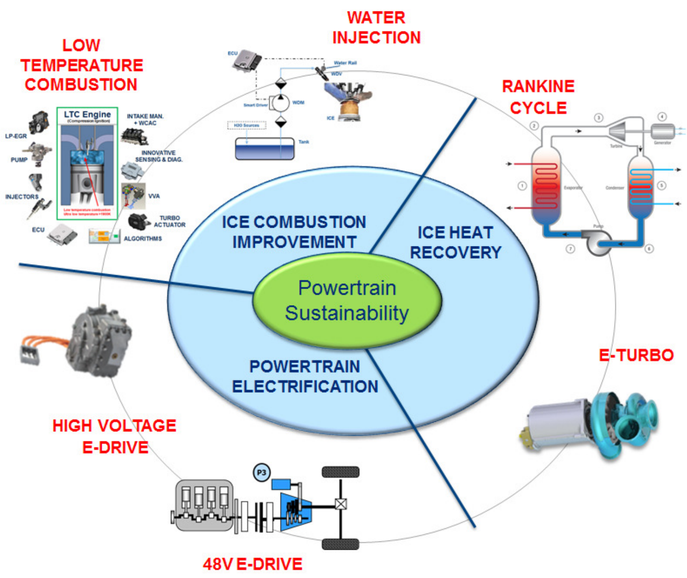

Fig. 8 Key powertrain technologies

FUTURE WORKS

- Improvement of the **models to take into account all significant vehicle loads** or **real driving conditions**, to evaluate the **Tank To Use**
- Completion of **analysis** and **definition** of **the key ICE technologies**

Main References: 1. De Cesare, M., Cavina, N., and Paiano, L., "Technology Comparison for Spark Ignition Engines of New Generation", SAE Int. J. Engines 10(5):2017
2. De Cesare, M., "Technology Overview for future Powertrains", Keynote Speech, International Conference of Electrical and Electronic Technologies for Automotive, 16-06-2017, Torino
3. Cavina, N., Rojo, N., Brusa, A., De Cesare, M. et al., "Investigation of Water Injection Effects on Combustion Characteristics of a GDI TC Engine", SAE Int. J. Engines 10(4):2209-2218, 2017
4. Ravaglioli, V., Ponti, F., De Cesare, M., Stola, F. et al., "Combustion Indexes for Innovative Combustion Control", SAE Int. J. Engines 10(5):2017.

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