Strategie di controllo per veicoli a trazione elettrica e ibrida

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Strumenti per la sostenibilità

A different future for automotive

- the problem of global warming: carbon dioxide
- non-infinite fossil fuels
- low efficiency of thermal engines (40% diesel MAX)
- particulate/NOx emissions in specific areas

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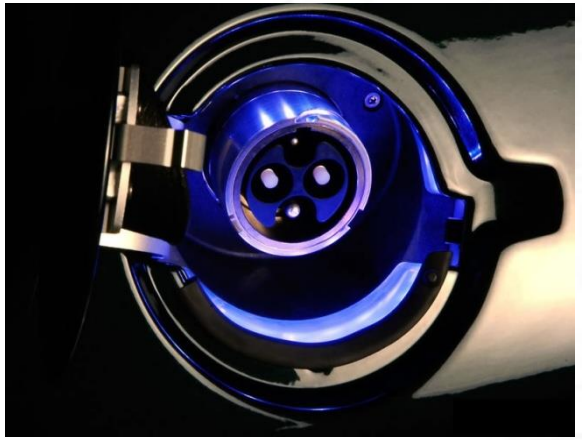

Vehicle electrification in perspective - 1

Emissioni CO2 dei veicoli:

13% del totale

Reduction policies →

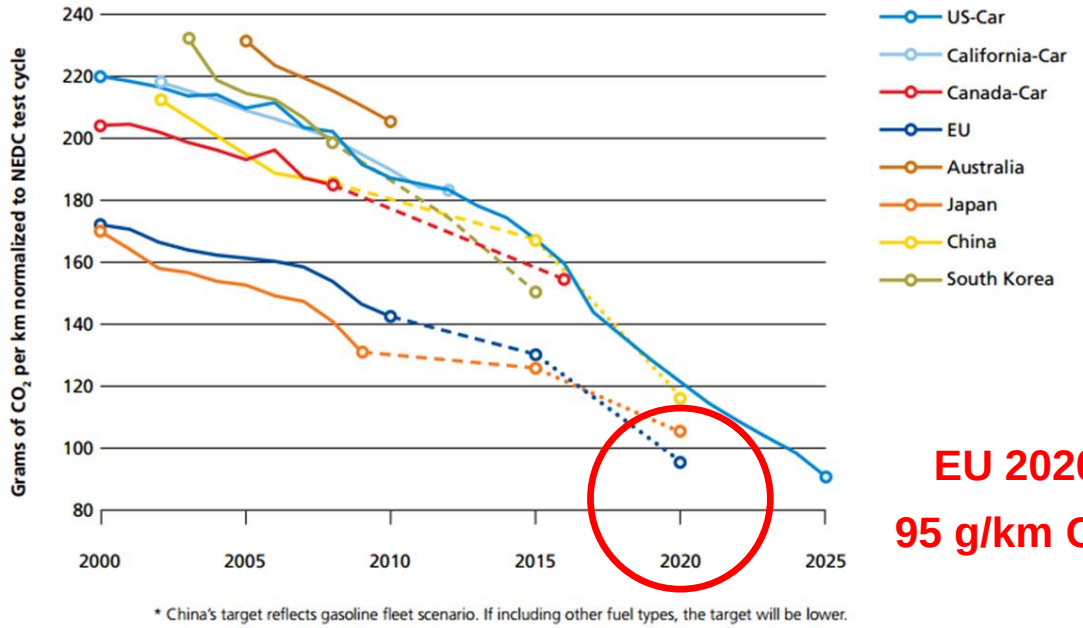

Figure 1: Declining CO_2 emission targets across the world

EU 2020:

95 g/km CO2

16 gennaio 2019: il Parlamento Europeo vota la riduzione

ulteriore delle emissioni CO2 per veicoli di nuova immatricolazione:

2025: -15% (auto e commerciali leggeri)

2030: -37.5% (auto), -31% (commerciali leggeri)

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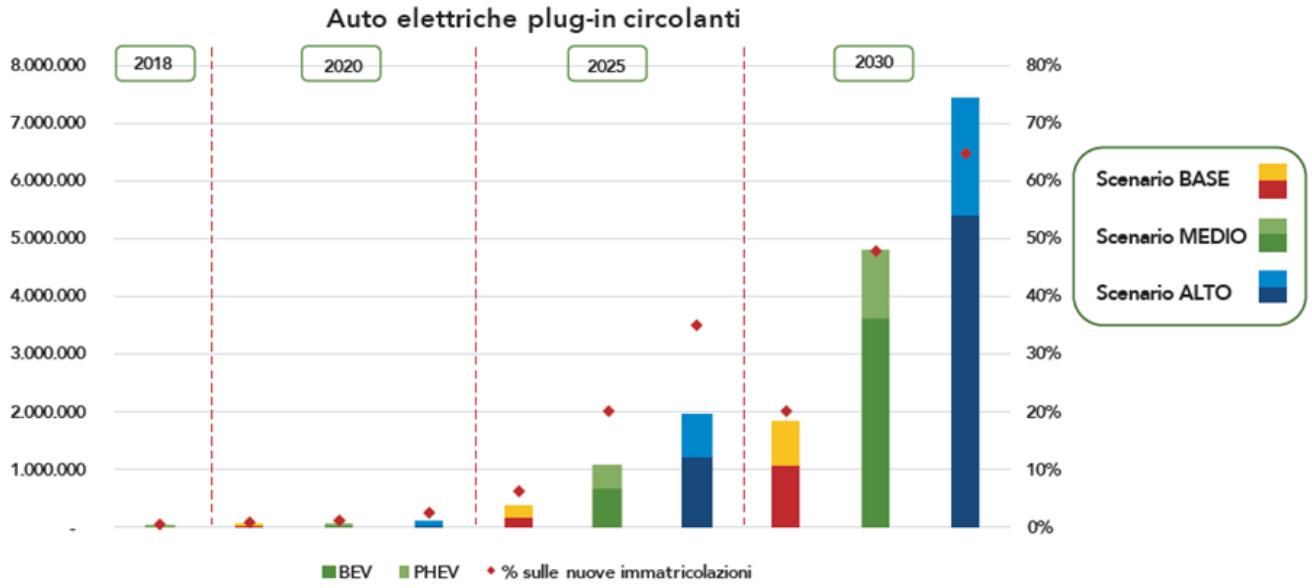
Vehicle electrification in perspective - 2

- **Il passaggio alla mobilità elettrica è avviato ed irreversibile**
- **Vari studi (PoliMI, Bloomberg, Reuters etc) concordano su una sensibile espansione di mercato a partire dal 2025**
- **Nei prossimi 8 anni gli investimenti dei costruttori verranno decuplicati: 255 Mld$ (Il Sole 24 Ore)**
- **Il cambiamento coinvolge nuovi player ed apre nuove opportunità**



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Vehicle electrification: the limits - 1

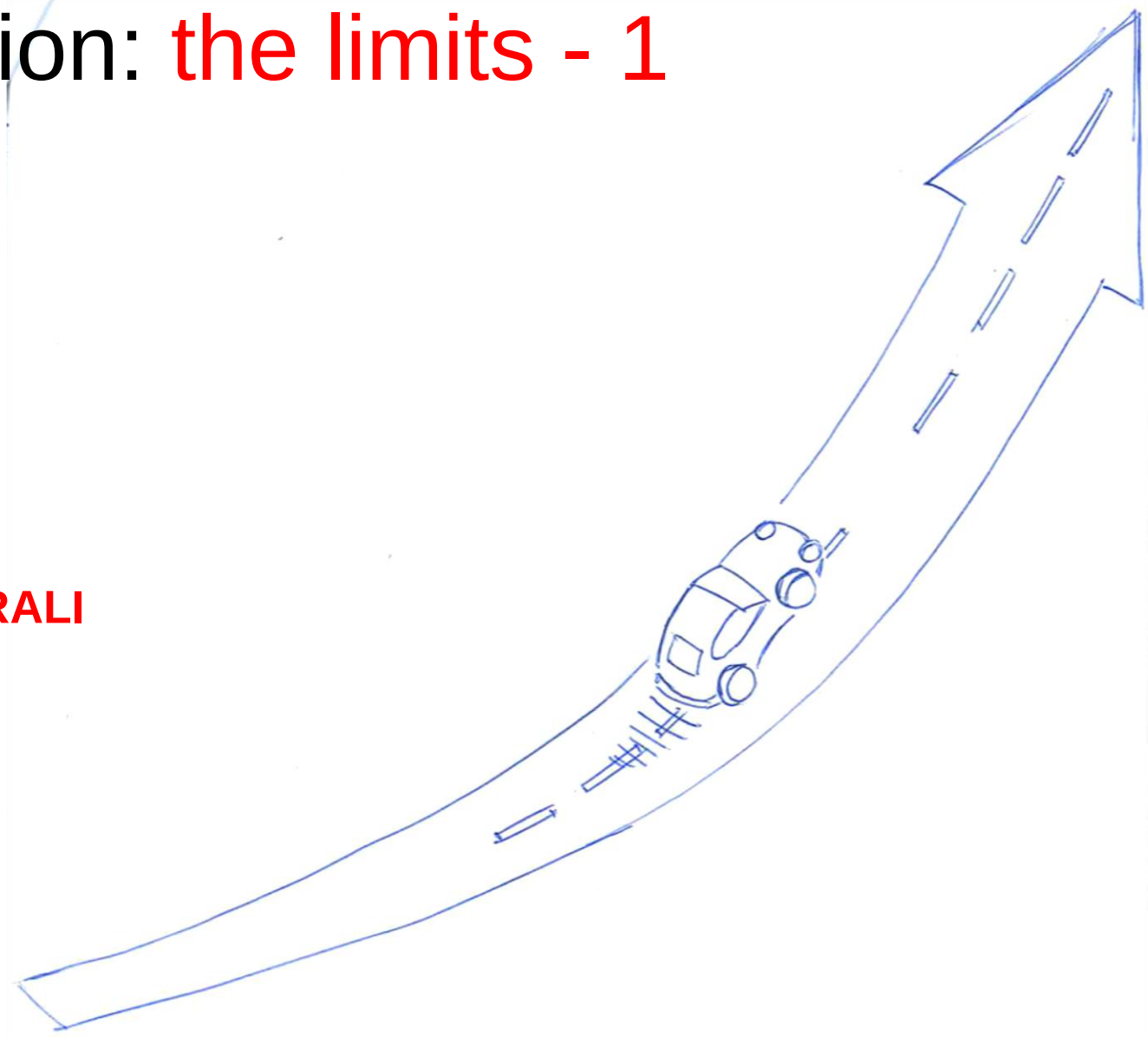
COSTI

INFRASTRUTTURE

WELL-TO-WHEEL / LCA

IMPATTO SOCIO-ECONOMICO

FATTORI SOGGETTIVI E CULTURALI



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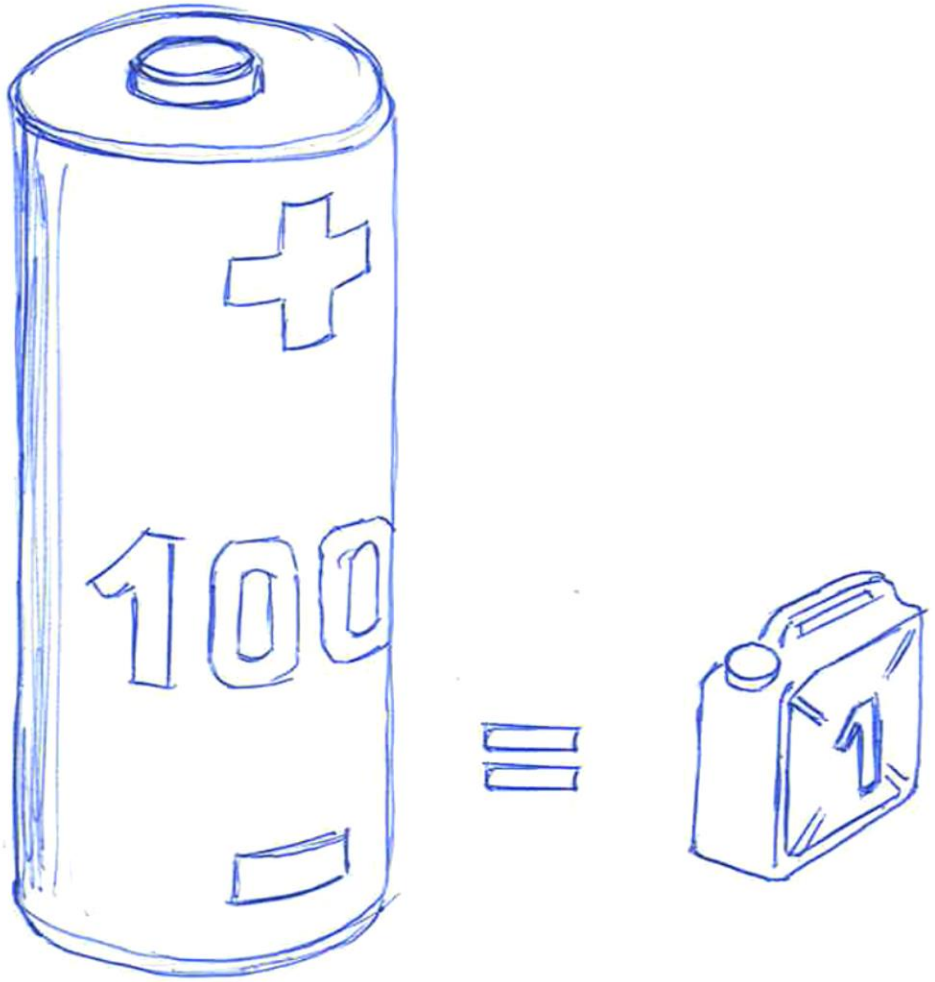
Vehicle electrification: the limits - 2



BATTERIE

- **Densità di energia**
- **Sensibilità alle condizioni ambientali**
- **Degrado sul singolo ciclo**
- **Degrado sul ciclo di vita**

Vehicle electrification: the opportunities

Electric motors offer many advantages:

•high efficiency and good reliability;

•a vigorous torque curve perfectly suited for road vehicle requirements;

•opportunities for fast/accurate torque control and regenerative braking.

VEHICLE DYNAMICS

ACTIVE SAFETY

DRIVER PERCEPTION

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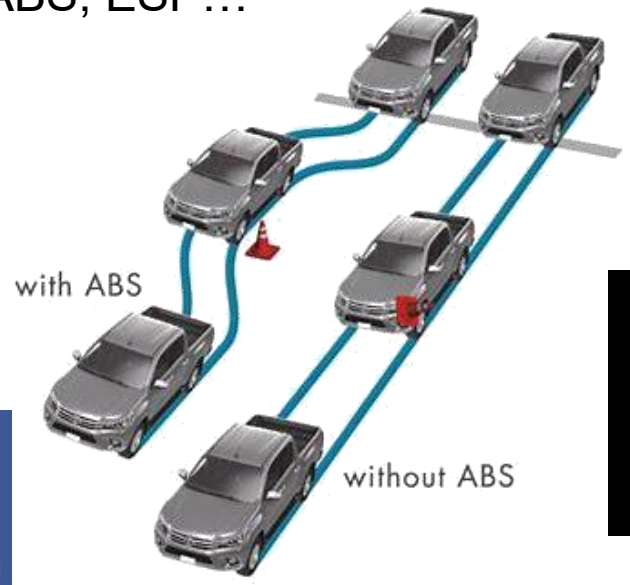
Active safety

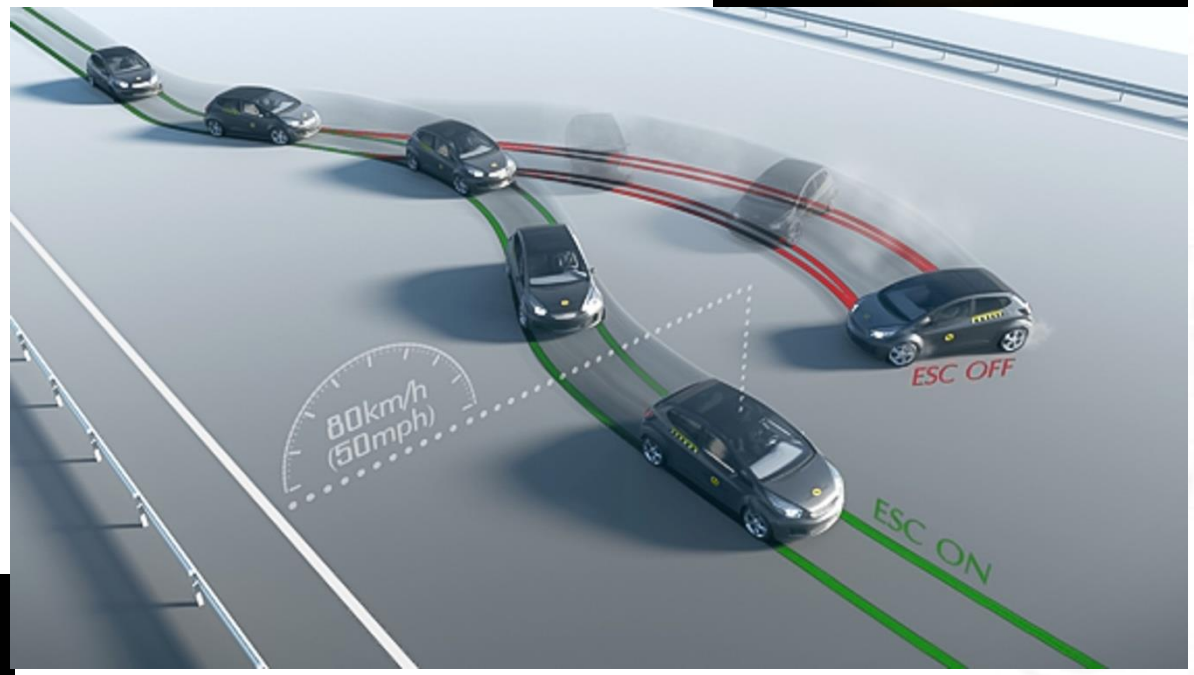
Every drivers could have a different reaction to unexpected events:

Active safety is the set of device systems that:

- should prevent the accidents;
- helps the driver during emergency maneuvers;
- works on steering response, brake pressure;
- controls the longitudinal wheel forces.

E.g. ABS, ESP…



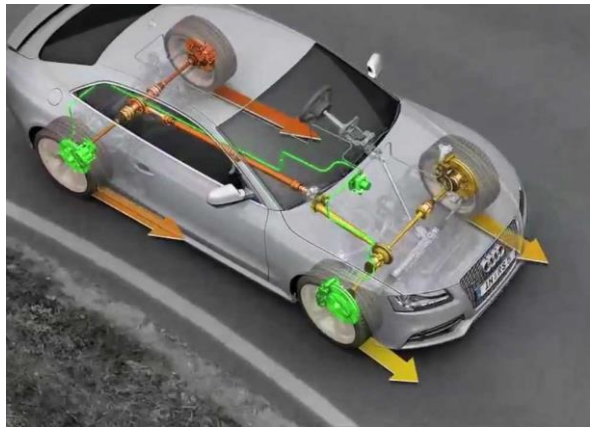


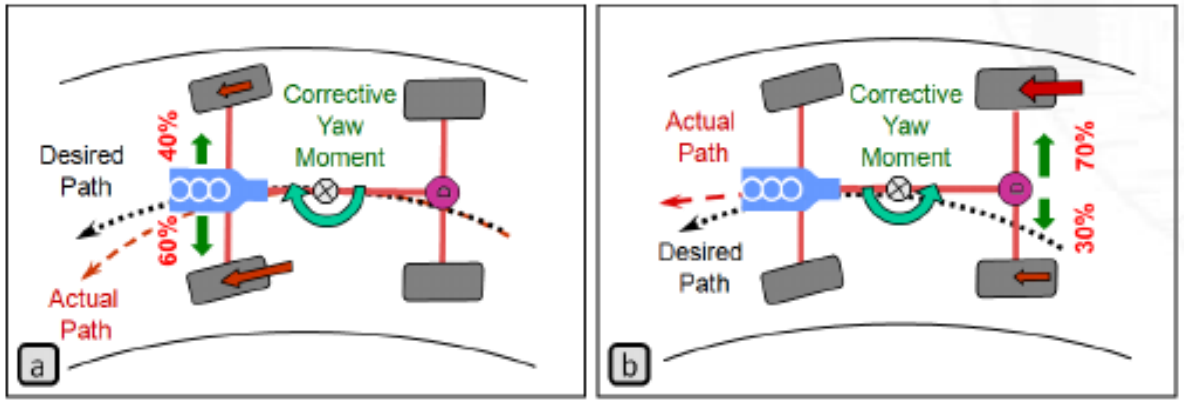
Tire forces are the heart of vehicle dynamics

Torque vectoring

“Torque vectoring is the precise and accurate control of the longitudinal traction and braking forces on the single wheel”

- Generating different longitudinal forces creates a moment around vertical axis;
- Torque vectoring can influence the handling of the vehicle;
- It’s limited with traditional vehicle because of the mechanical differential and the internal combustion engine.





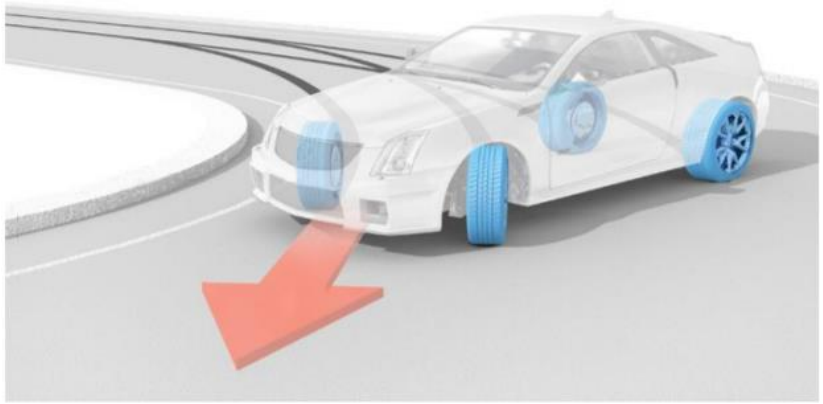
How can we integrate the active safety with electrification?

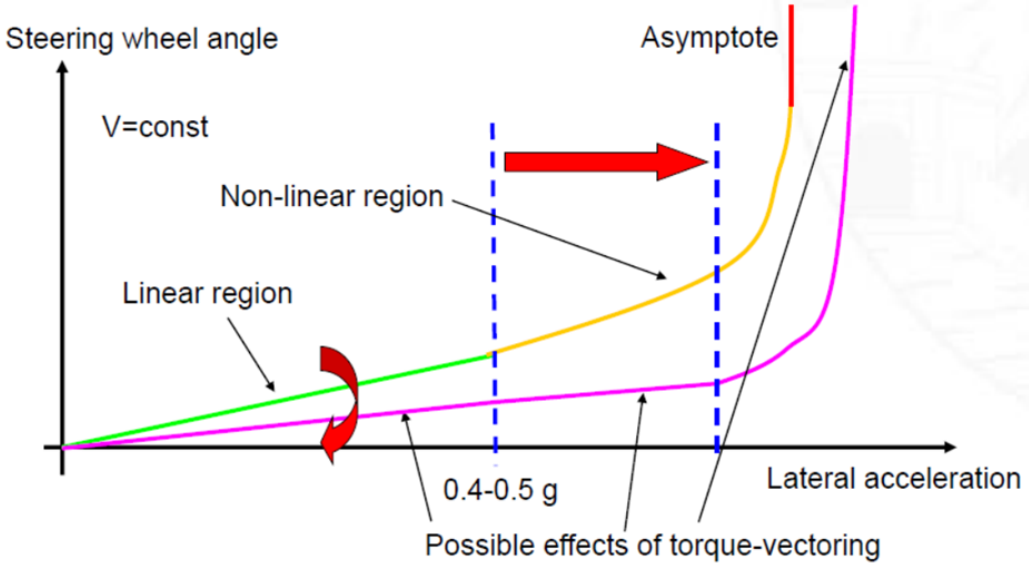
Active safety ⟷ ***Electrification***

Create a car with all active controls directly implemented in the logics of 2 or 4 electric motors:

•Modify the understeer curve of the vehicle in real time to reach a target curve set;

•optimize performance or efficiency without changing the mechanical configuration.

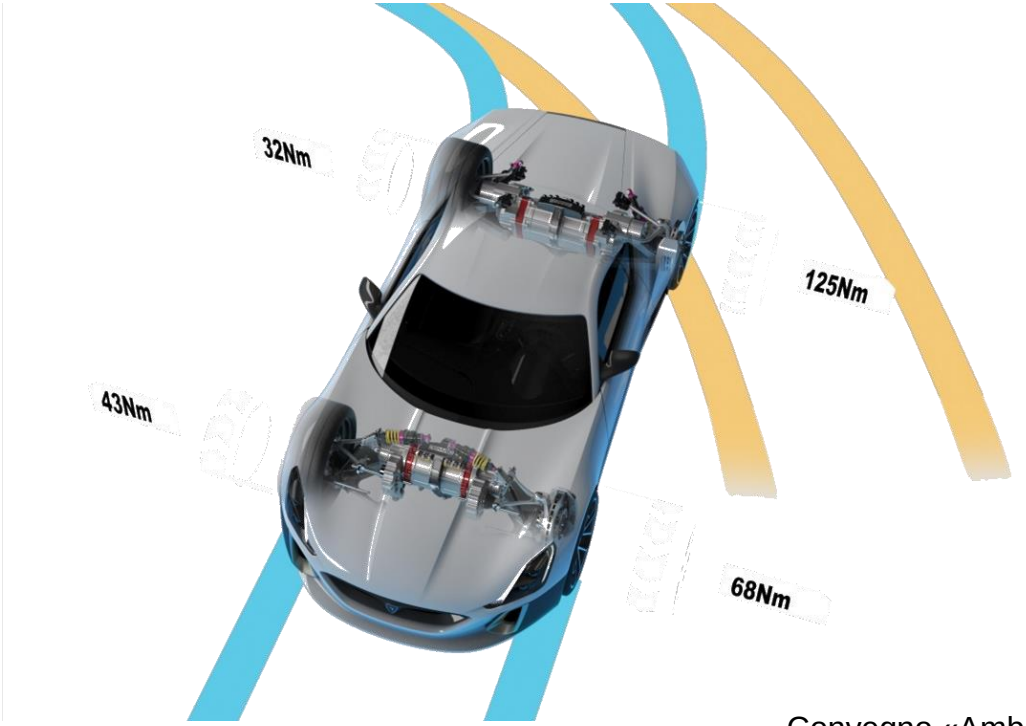




Project

Objective: creation of basic code for the vehicle dynamics control model, installed in the vehicle control unit.

We'll generate different traction forces depending on driver needs and road conditions



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Project step -1

Test on dynamic platform

- Specific maneuvers
- Reference production car
- Optical sensor: Correvit

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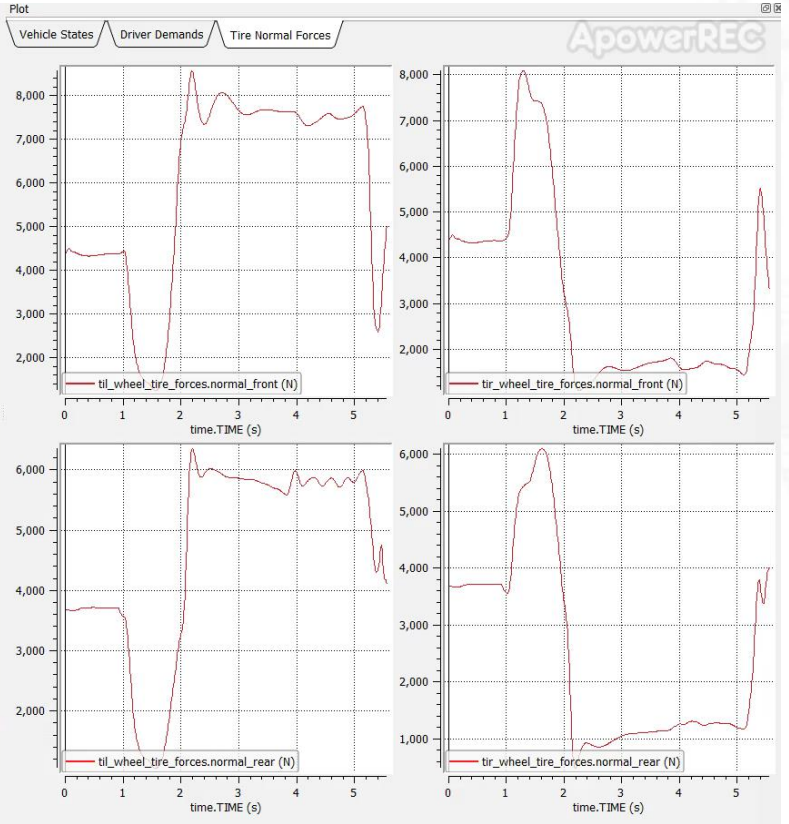
Project step -2

Create a virtual car model

- VI-CarRealTime model
- Validation with collected data

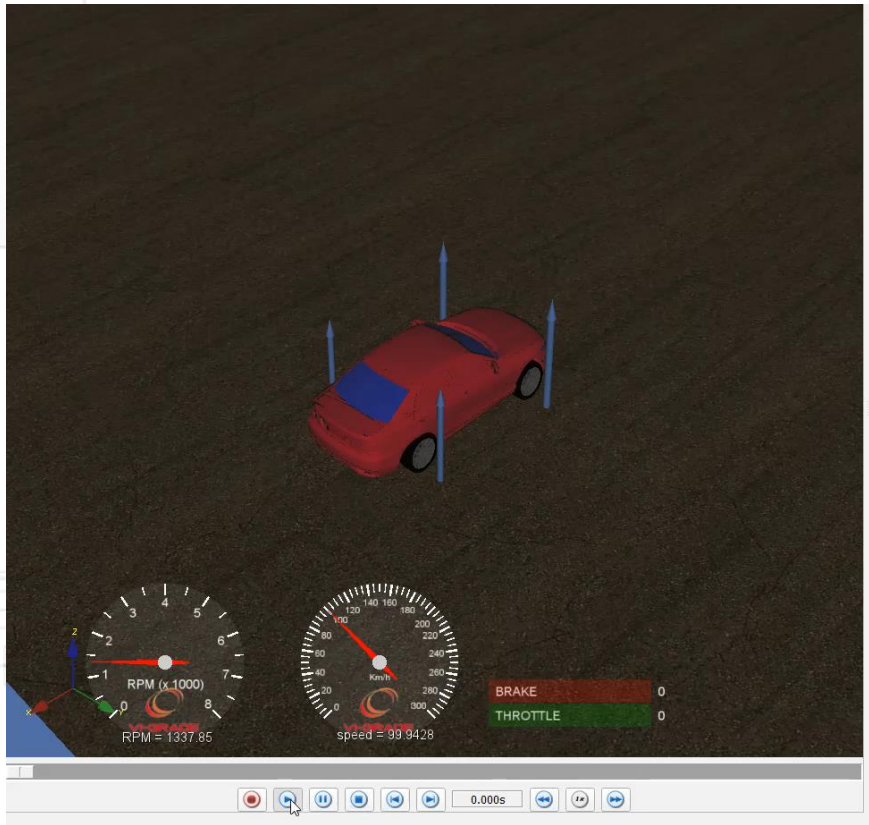


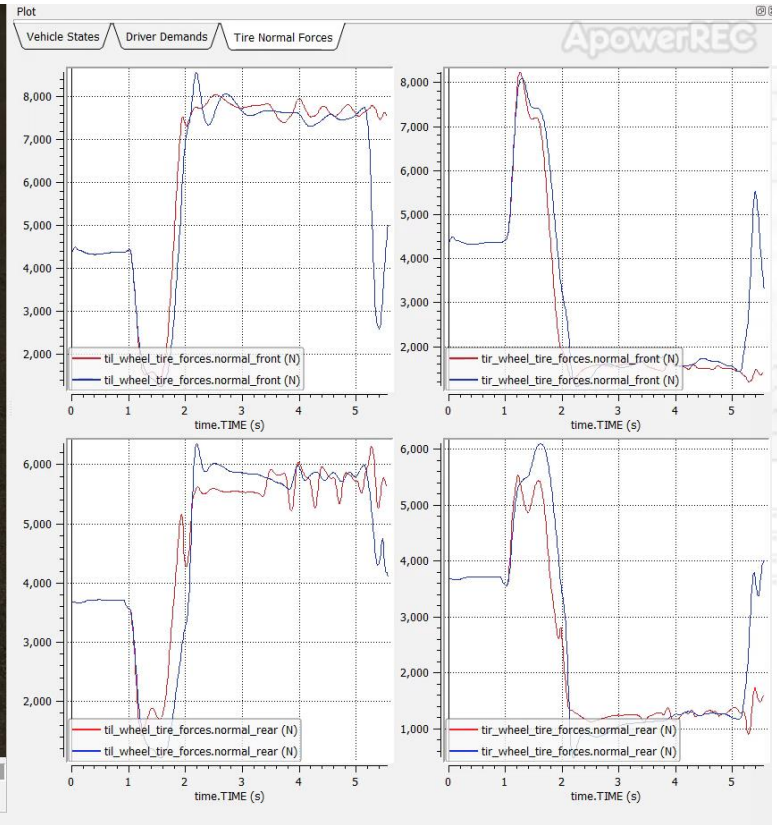
Project step -3

Create a Matlab-Simulink code to provide direct traction control, rear wheel steering and torque vectoring through estimation of vehicle sideslip angle, because optical sensor is too expensive for production cars.
Different driving modes: for max performance or max efficiency and energy saving

Project step –4

Co-simulation campaign: offline by means of software Vi-CarRealTime and Matlab&Simulink





Project step –5

Co-simulation campaign: Online with static and dynamic driving simulator:
«Human-in-the-loop» calibration to take perception and human factors into account

Project step –6

Create a prototype controller for the ECU specifics for the communication with electrics powertrain. NO ABS, NO ESP, but only one controller.
«Hardware-in-the-loop» simulation with static and dynamic simulator

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Project step –7

Prototype: full electric, multi-motor vehicle:

- Use torque vectoring strategy to maximize active safety and energy efficience
- Test for validating the model and calibration
- New driving experience → Fun to drive
- Collaboration with automotive companies

Thanks for your attention