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SOCIETAL MEGATRENDS & TRENDS IN VEHICLE TECHNOLOGIES

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OUTLINE

- Introduction: From societal megatrends to automotive trends
- Alternative fuels
  - CNG and LNG
  - Electric and hybrid vehicles
  - Fuel cell and hydrogen
- Autonomous Driving
- Conclusion

INTRODUCTION
From societal megatrends
To automotive trends

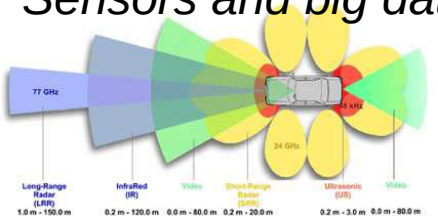
WORLD IS CHANGING DEEPLY & QUICKLY

Urbanization

Accident

Artificial Intelligence

Sensors and big data

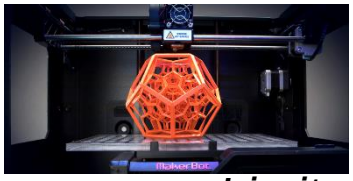


Individualization of Mobility Needs

Congestion

Digitalization

3D printing



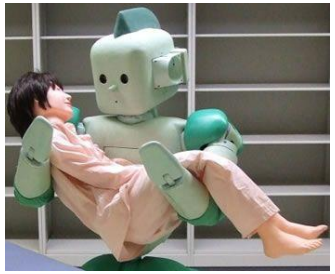
Connectivity

Limited Resources

Population ageing

Criminality

Healthcare



Climate change

Air pollution

Cost of fuel

Waste et recycling

GLOBAL MEGATRENDS

- Acceleration factor of **Technologies** and ubiquitous presence of **Digital World** with a growing importance of **Health**

POWER OF TECHNOLOGY
- "Innovation to zero"
- Ambient technology
- Robotics and AI
- Miniaturization
- 3D printing…

DIGITAL WORLD AND CONSUMER TRENDS
- Connected objects
- Using instead of owning
- Augmented and virtual reality
- Demand for security

HEALTH
- Thinner boundary between living and non living
- New health issues
- Elderly people
- Health, wellness and well-being
- eHealth

AUTOMOTIVE TRENDS

- Continued focus on **Energy Efficiency** and growth of **Digital World** with impact on **Mobility**

ENERGY EFFICIENCY

- Low emission regulation
- Powertrain electrification
- Renewable energy
- E-vehicle as a smart grid component
- Lightweight materials
- Recycling

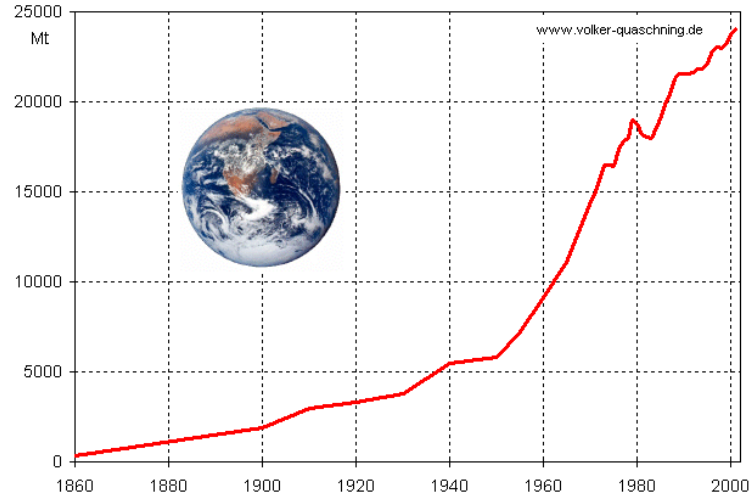
CONNECTED CAR

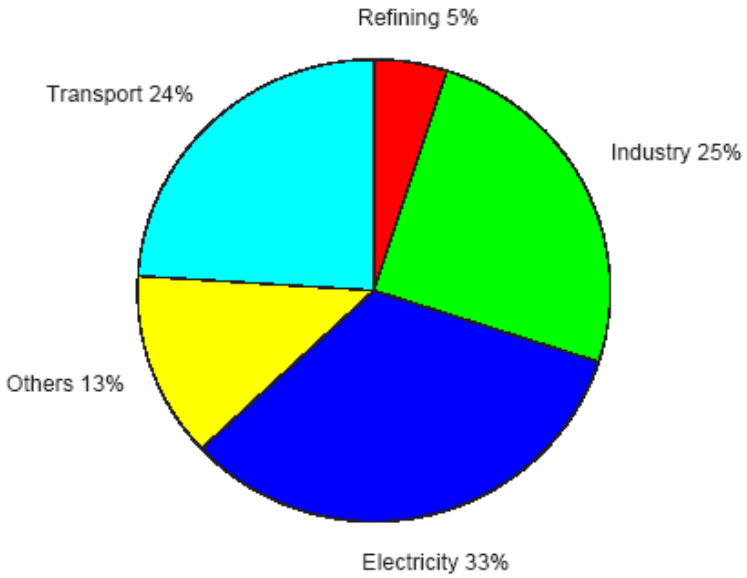
- Big data
- Safety and remote services
- Navigation, location based services
- Infotainment services
- Mobility services
- Payment and e-commerce services

MOBILITY

- Multimodal mobility
- Car sharing
- Car pooling
- Autonomous driving
- Integrated mobility ecosystems
- Low emission zones

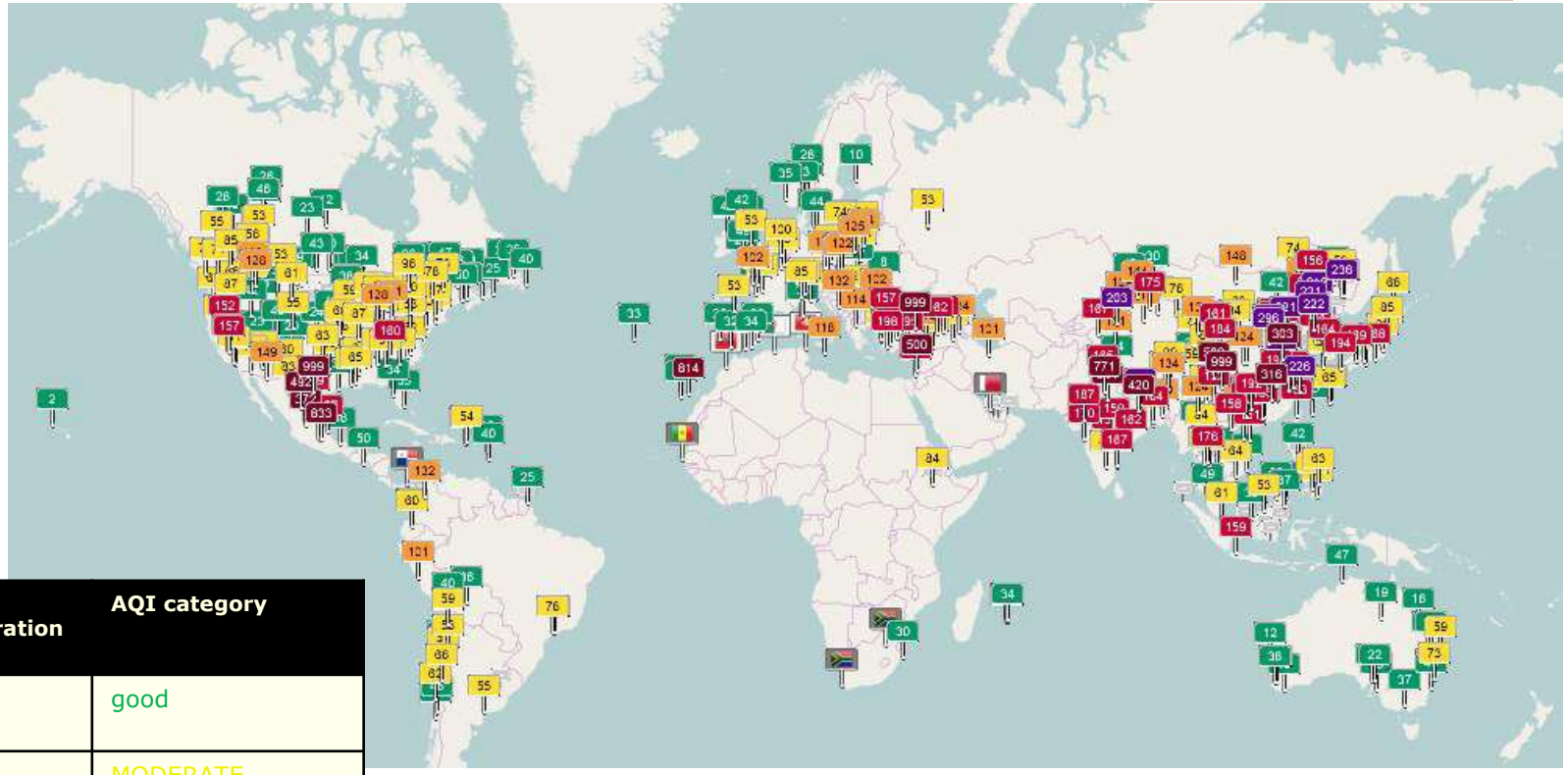
REDUCING CO_2 EMISSIONS





- Global warming related to human activities and use of fossil fuels
- Transport is one major contributors to CO_2 emissions
- Reduction of emissions by 50% by 2030 (ERTRAC):
  - Substituting petrol fuels by fuels with low carbon emissions or fuels with low LCA emissions (biofuels)
  - Improve the powertrain fuel efficiency
  - Reduce the mass, which often antagonistic with the demand for greater safety, comfort, etc. → 6% to 12% per 10%

AIR POLLUTION IS AND REMAINS A WORLD WIDE ISSUE



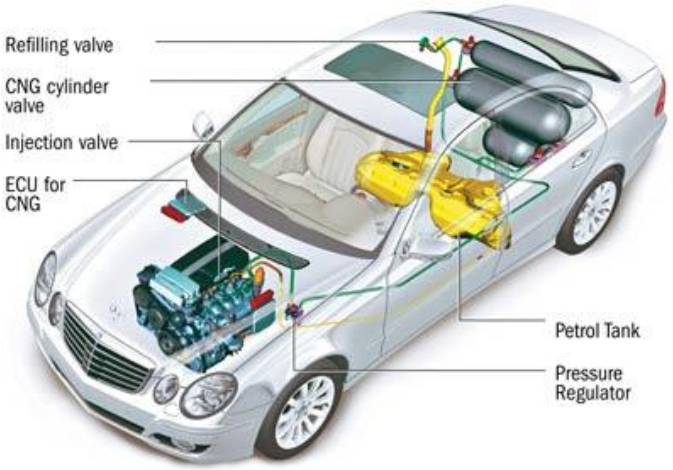
AQI	PM2.5 concentration µg/m³	AQI category
0 to 50	0 to 12	good
51 to 100	12 to 35	MODERATE
101 to 150	35 to 55	UNHEALTHY FOR SENSITIVE GROUPS
151 to 200	55 to 150	UNHEALTHY
201 to 300	150 to 250	VERY UNHEALTHY
300 to 500+	250 to 500	HAZARDOUS

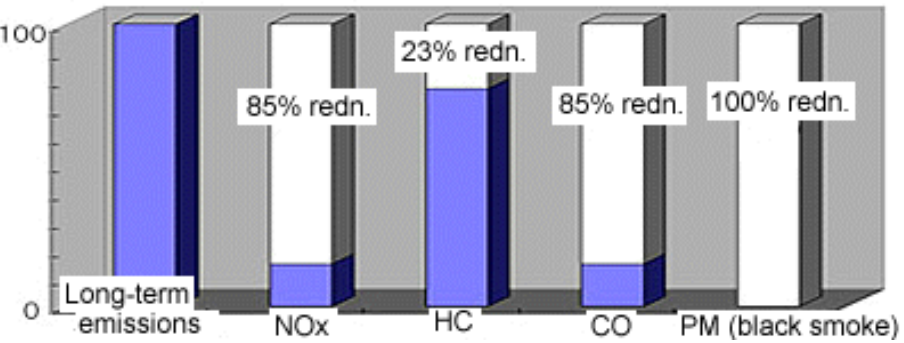
AQI – Thursday 07th Nov., 2016– 09:14 French Time
Extract from AQICN website - www.aqicn.org

Air pollution is now considered by OMS "the world's largest single environmental health risk," with more than three million people dying every year as a result.

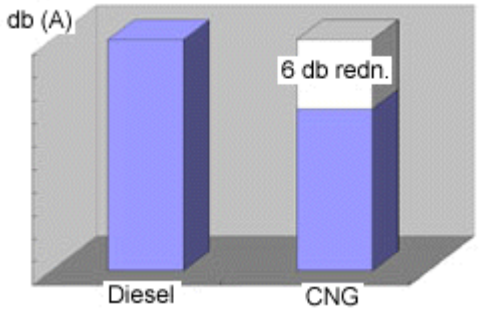
ALTERNATIVE FUELS

NATURAL GAS (CNG & LNG)





IVECO Stralis Cursor 11



- Natural Gas is an excellent alternative fuel:
  - Easy adaption of classic internal combustion engines
  - Large reserves of natural gas are available
  - Reduction of CO_2 emissions (-10%) and air pollution (PM: -95%)
- Target: optimization of engine efficiency: allows a reduction of 5 to 10% of CO_2 emissions compared to Diesel engine
- Target by EU: substitution: 10% in 2020

NATURAL GAS (CNG & LNG)

Energy per storage volume for common fuel

	Density kg/m^3	LHV kJ/kg	Energy MJ/m^3		Volume (for same energy)
Gasoline	750	42 690	32 020		
Diesel fuel	835	42 770	35 710	+11%	×0.9
Gaseous methane 1013 hPa, 273 K	0.716	50 010	36	– 100%	×889
Gaseous methane 20 Mpa, 293 K	173 (AGA8)	50010	8 652	– 73%	×3.7

(1 MPa = 10 bars)

Questions to be solved

- Emissions of CH_4 and development of specific after treatment to be developed
- Refueling station network still under construction: 68 stations in Belgium mostly in Flanders
- CNG (200/350/800 bar) Volume per unit of energy content still high ➔ Limited autonomy: 300 to 400 km
- LNG (3 bars @ -143°C / 8 bars @-130°C): Volume reduced by 2.4 ➔ Extension of autonomy to 700 to 800 km and over

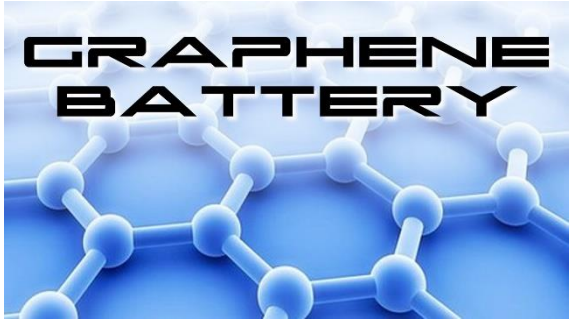
ELECTRIC VEHICLES
AND HYBRID ELECTRIC VEHICLES

ELECTRIC VEHICLES

- Advantages
  - Nicely fitted to urban driving
    - Zero local emission
    - Great driving comfort
  - High energy efficiency
    - Lower energy cost: 20 kWh/100 km
- Drawbacks: the batteries!
  - New customer habits to develop
    - Charge time (1 to 6 hours)
    - Autonomy between 130 km and 300 km (strongly dependent on the weather conditions)
  - Smaller size vehicles
  - Reliability is still to be fully demonstrated

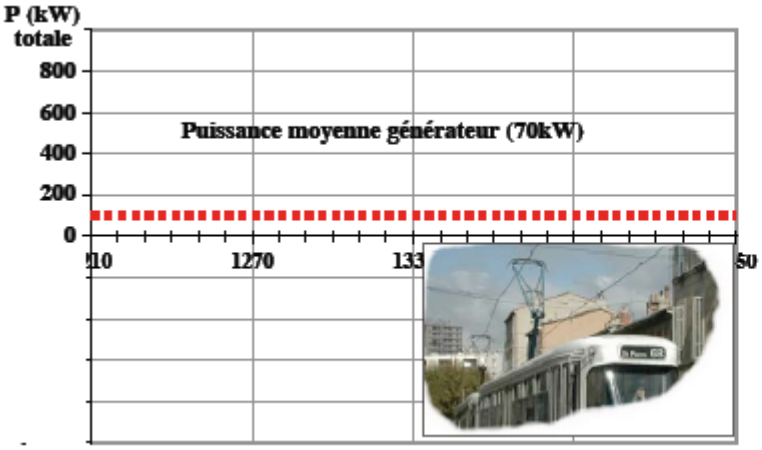
ELECTRIC VEHICLE

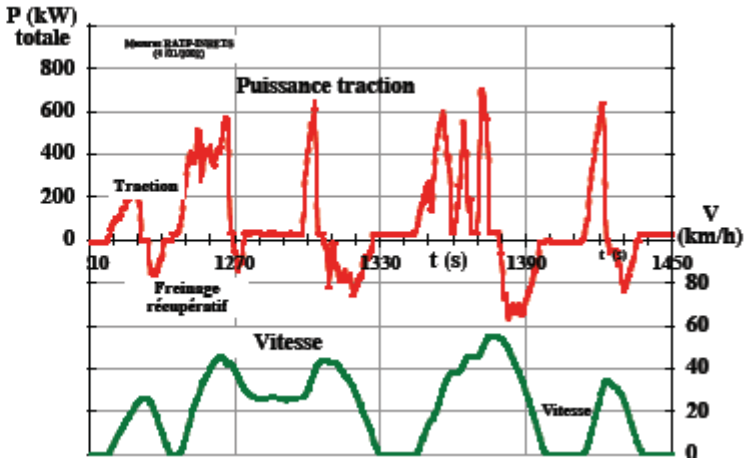
- Urban applications are targeted
  - Driving comfort and efficiency
  - Low emission zones (LEZ)
  - Night delivery
- Charging infrastructure is currently growing but still limited:
  - Public charging infrastructure v.s. company private charging stations
- Batteries: new developments
  - Temperature sensitivity
  - Recycling
  - Graphene batteries: +45% capacity / charging 12 times faster…
  - When will the technology be available??
- Future research:
  - Fast inductive charging
  - Electrified highway by Siemens



HIGHLY VARIABLE OPERATING CONDITIONS

- Major difficulty of propulsion systems: the highly variable operating conditions (torque, regime)
  - Target: sizing to average power consumption!
  - Approach: store the energy ➔ Batteries
  - Recover energy : Two energy converters



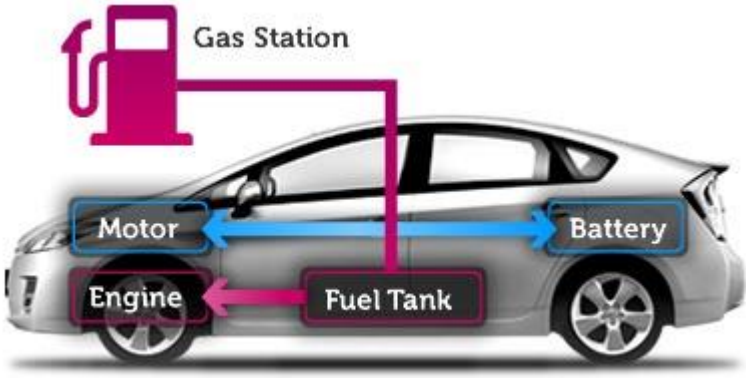


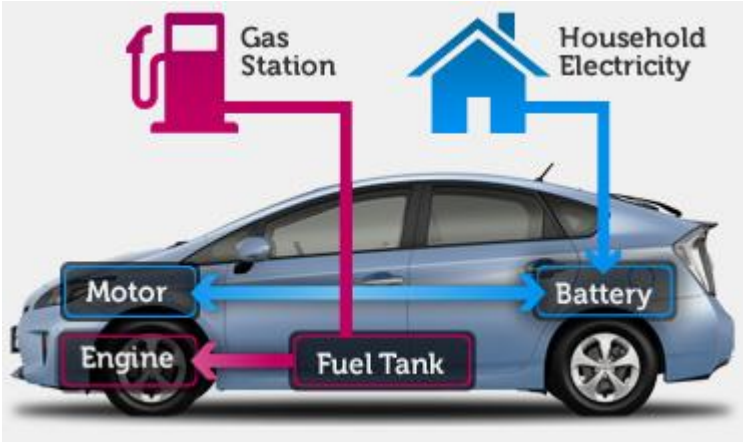
Source G. Coquery, INRETS

- Hybrid vehicles combine two sources of energy, energy storage, and energy conversion systems.

HYBRID ELECTRIC VEHICLES: CHARGE SUSTAINING VS PLUG-IN

- Charge sustaining:
  - Energy is produced on-board by engine only.
  - Easy adaptation of users
  - Limited energy efficiency improvement
  - Petrol dependency

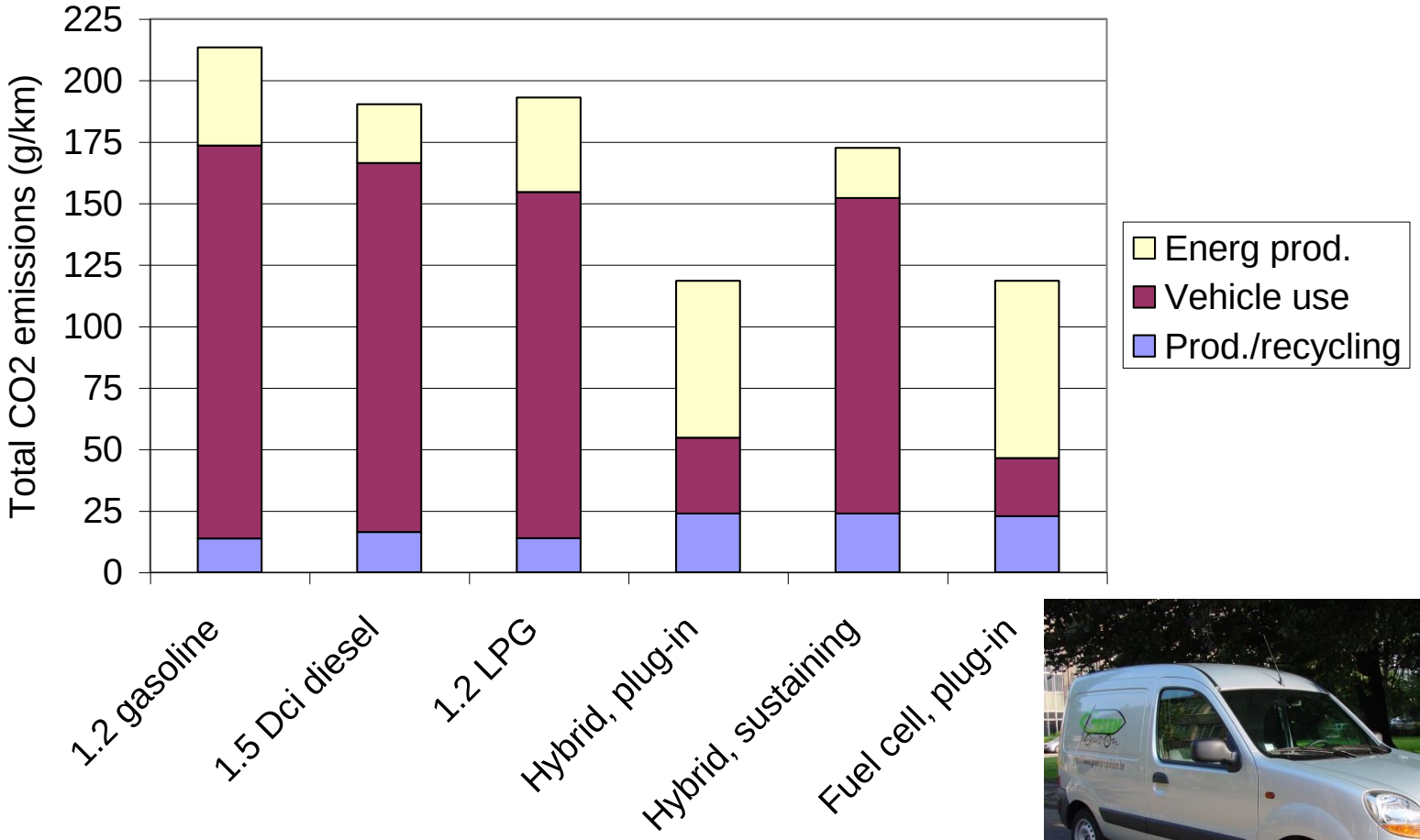




Source: Toyota

- Plug-in hybrid:
  - Energy is either produced on-board or by using plug-in capacity to the network.
  - Long range and low emission performance
  - Energy consumption: l/100km and kWh/100km ➔ access to renewable energy sources

HYBRID VEHICLES: ABOUT THE USEFULNESS OF PLUG-IN STRATEGY



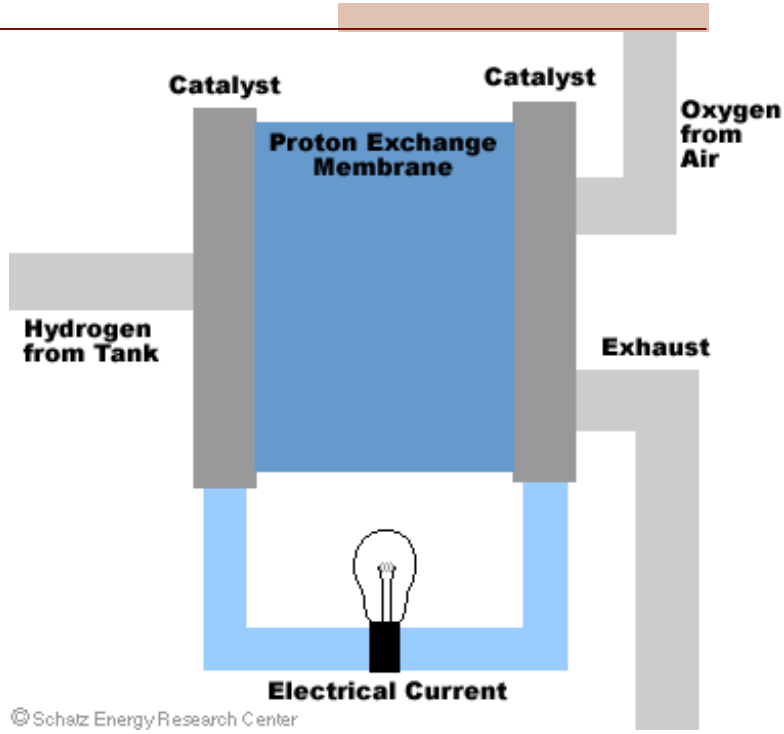
Source: www.green propulsion.be

Renault Kangoo Hybrid
Green Propulsion

FUEL CELL VEHICLE

FUEL CELL PRINCIPLE

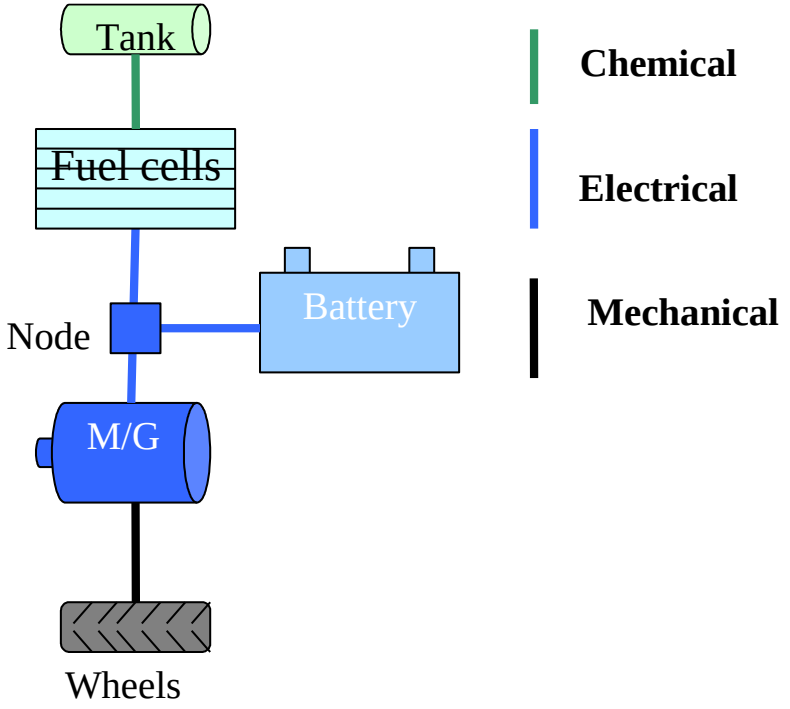
- Fuel Cell carries out a direct conversion of the fuel chemical energy into electrical energy
- Electrochemical reaction (oxide-reduction) without flame
- The hydrogen $H_2 - O_2$ fuel cell: inverse reaction of water electrolysis
- High fuel efficiency (>50%)
- Major issues:
  - Cost related of electrodes made of precious metal, membranes
  - Reliability
- Hydrogen technology: a real start?



Viessmann-Panasonic domestic FC

FUEL CELL POWERED VEHICLES

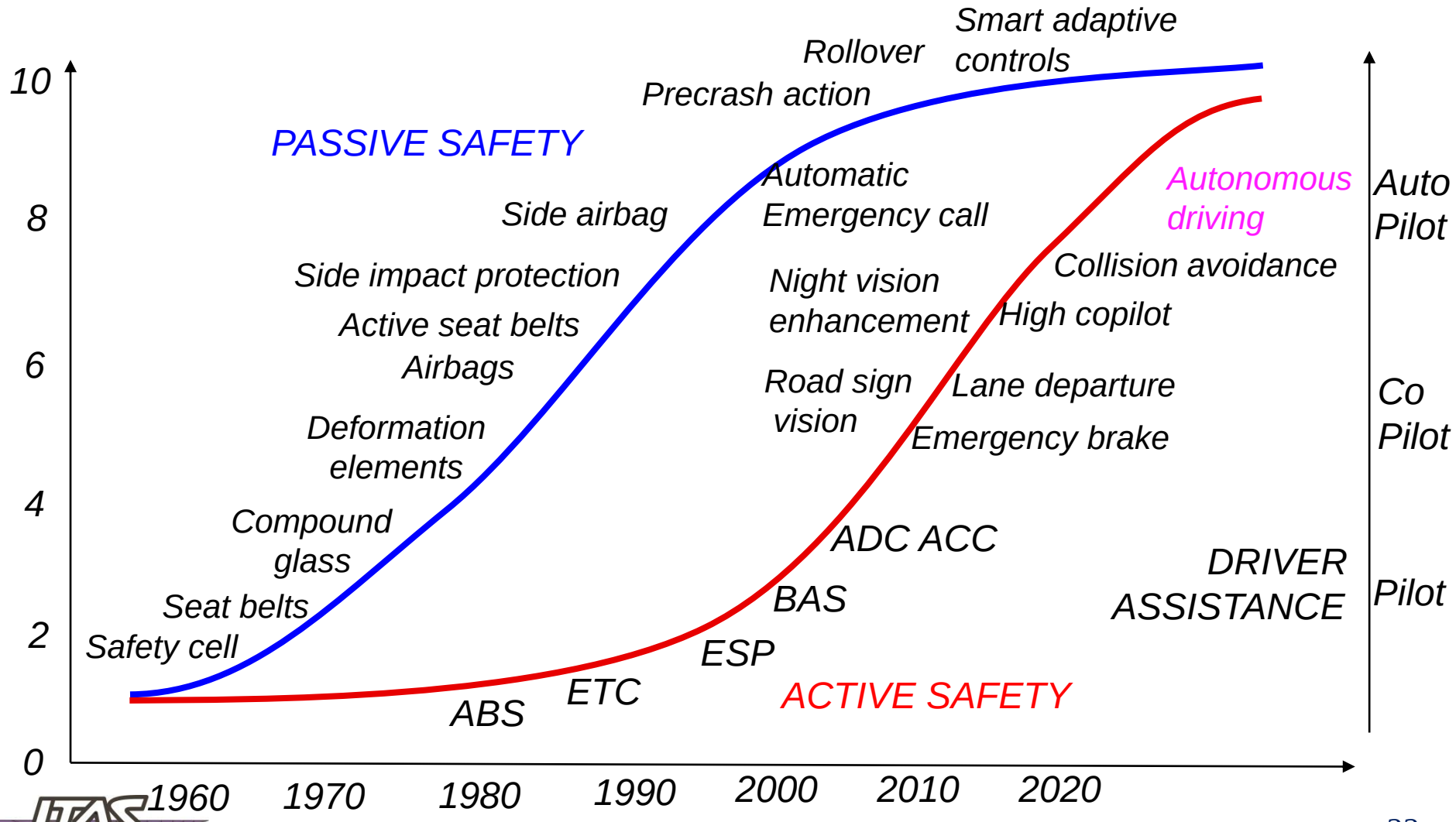
- Zero emission vehicle:
  - No pollutant emission except H_2O
  - Nearly silent operation
- Powertrain layout based on series hybrid architecture
  - Energy storage based on batteries or supercaps
  - Recovery of braking energy
  - Autonomy of 400 to 500 km
- Hydrogen production & distribution
  - H_2 or plug-in hybrid on electrical network
  - H_2 production and distribution?



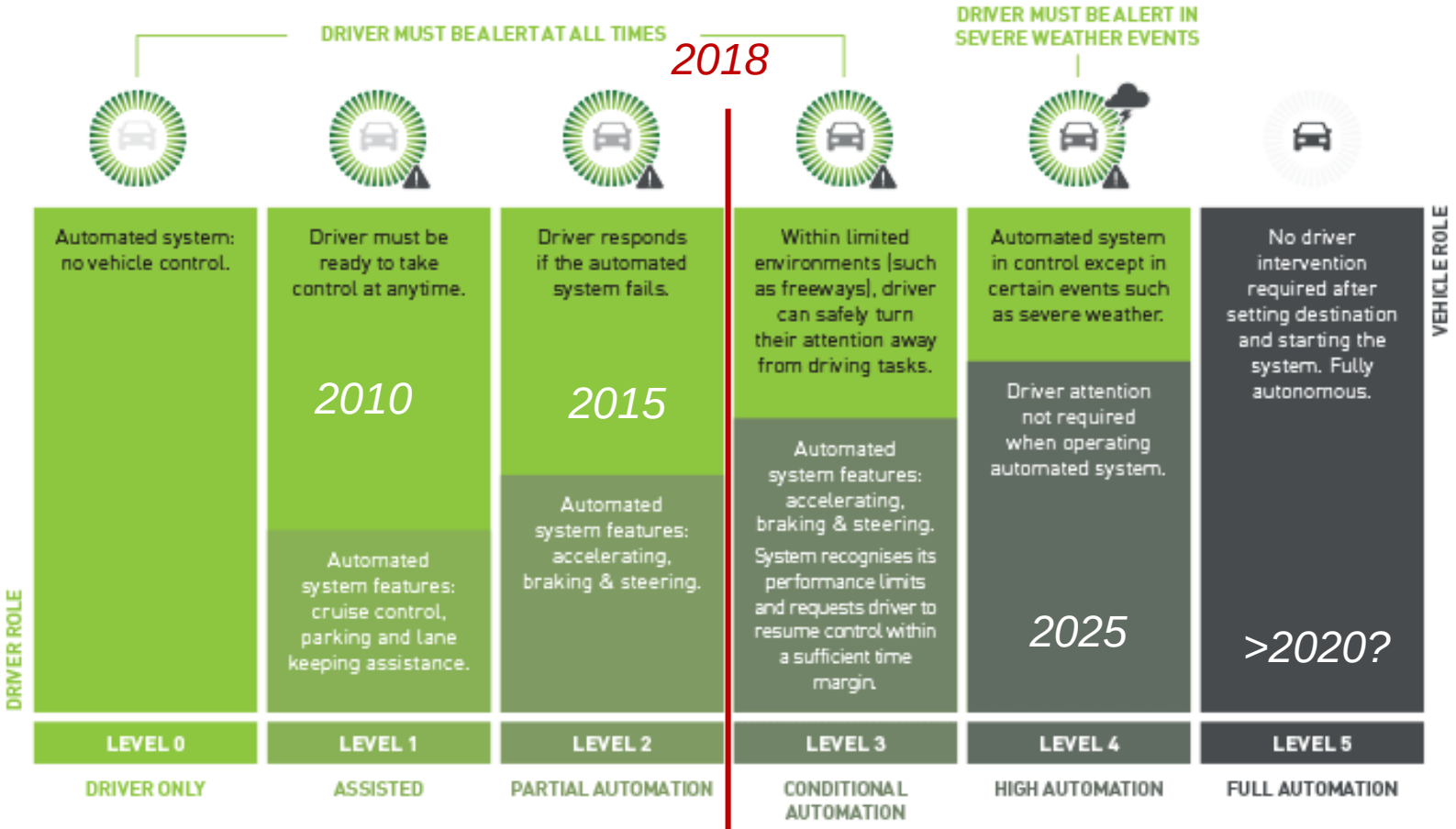
Toyota Mirai

AUTONOMOUS DRIVING

AUTONOMOUS VEHICLES: IN THE TRACK OF ADAS

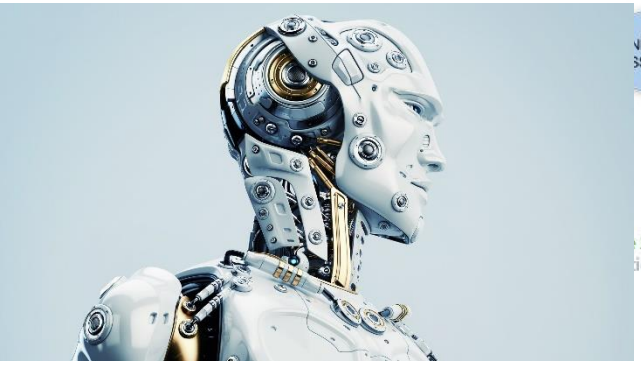


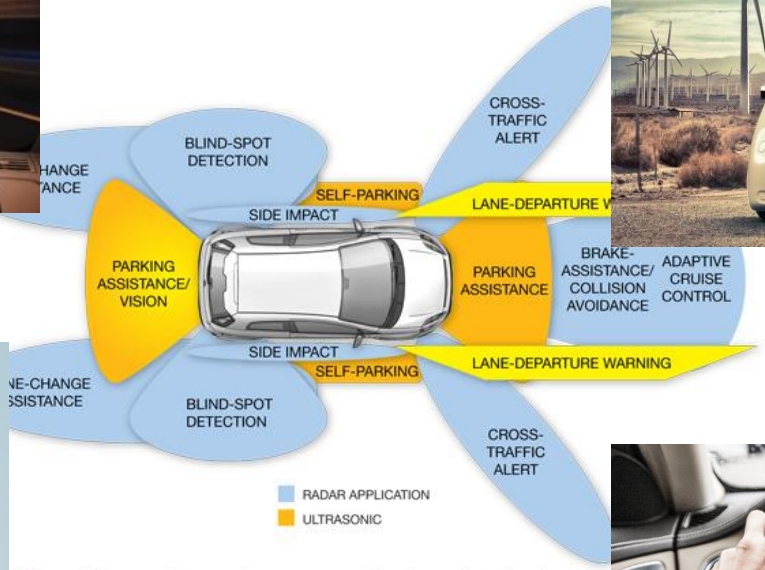
AUTONOMOUS VEHICLES: THE CROSSROAD



AUTONOMOUS VEHICLES: THE NEW PLAYERS

- Key element of autonomous vehicles: New technologies
  - Artificial intelligence, Machine learning algorithms,
  - Vision, mapping…
- Arrival of new players: Google, Apple…

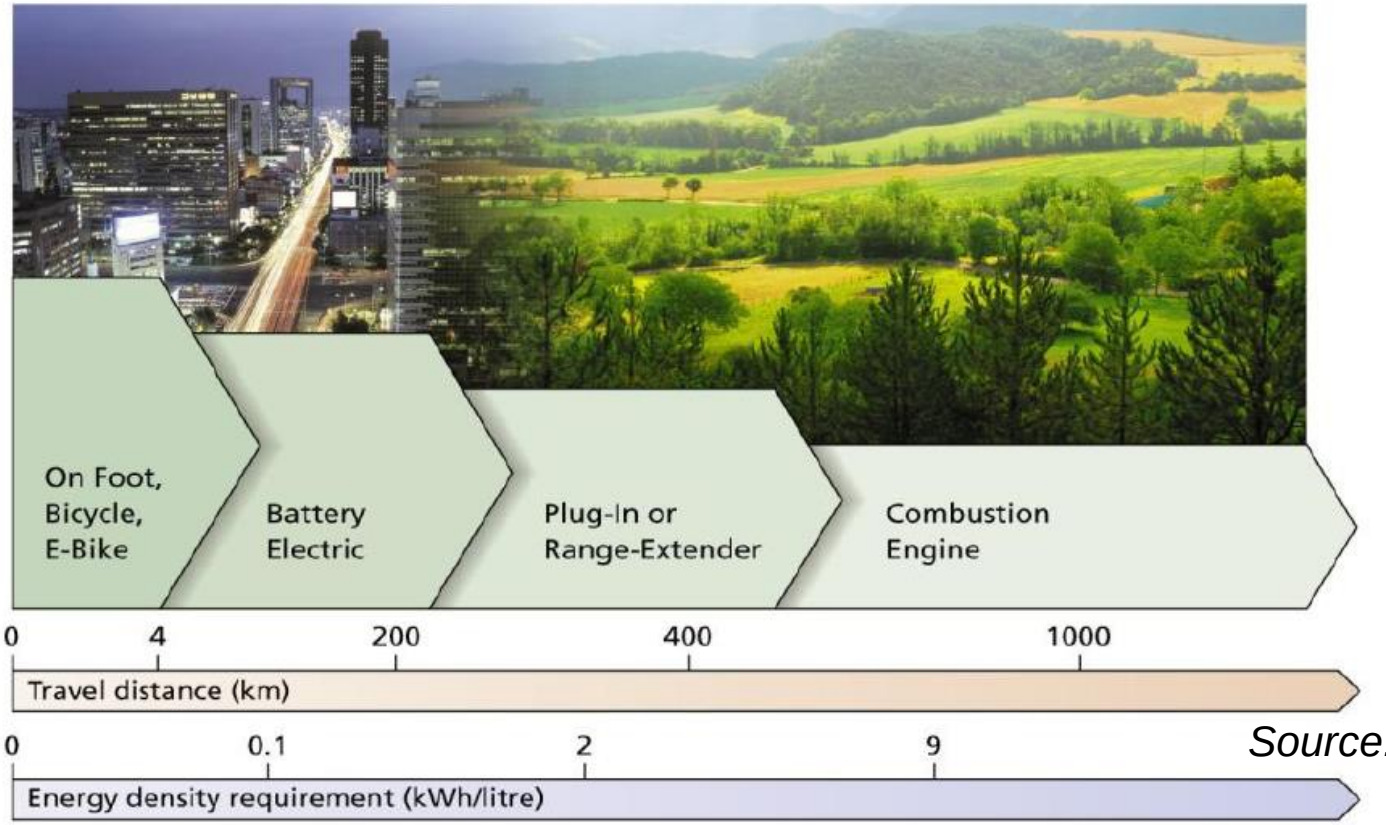




2 Several driver-assistance systems are currently using radar technology to p
tion, parking assistance, collision avoidance, and other driver aids (courtesy Ar

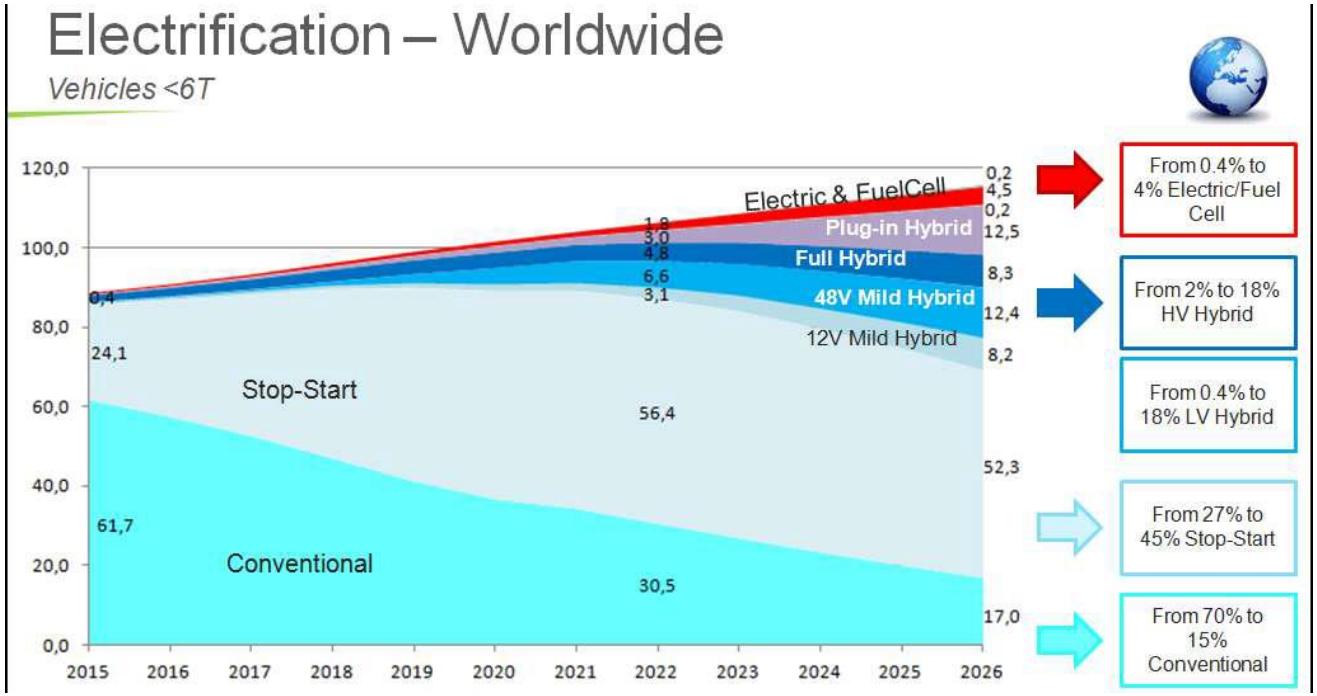
CONCLUSION

SOLUTIONS DEPEND ON USAGE PROFILE!



Source:ERTARC

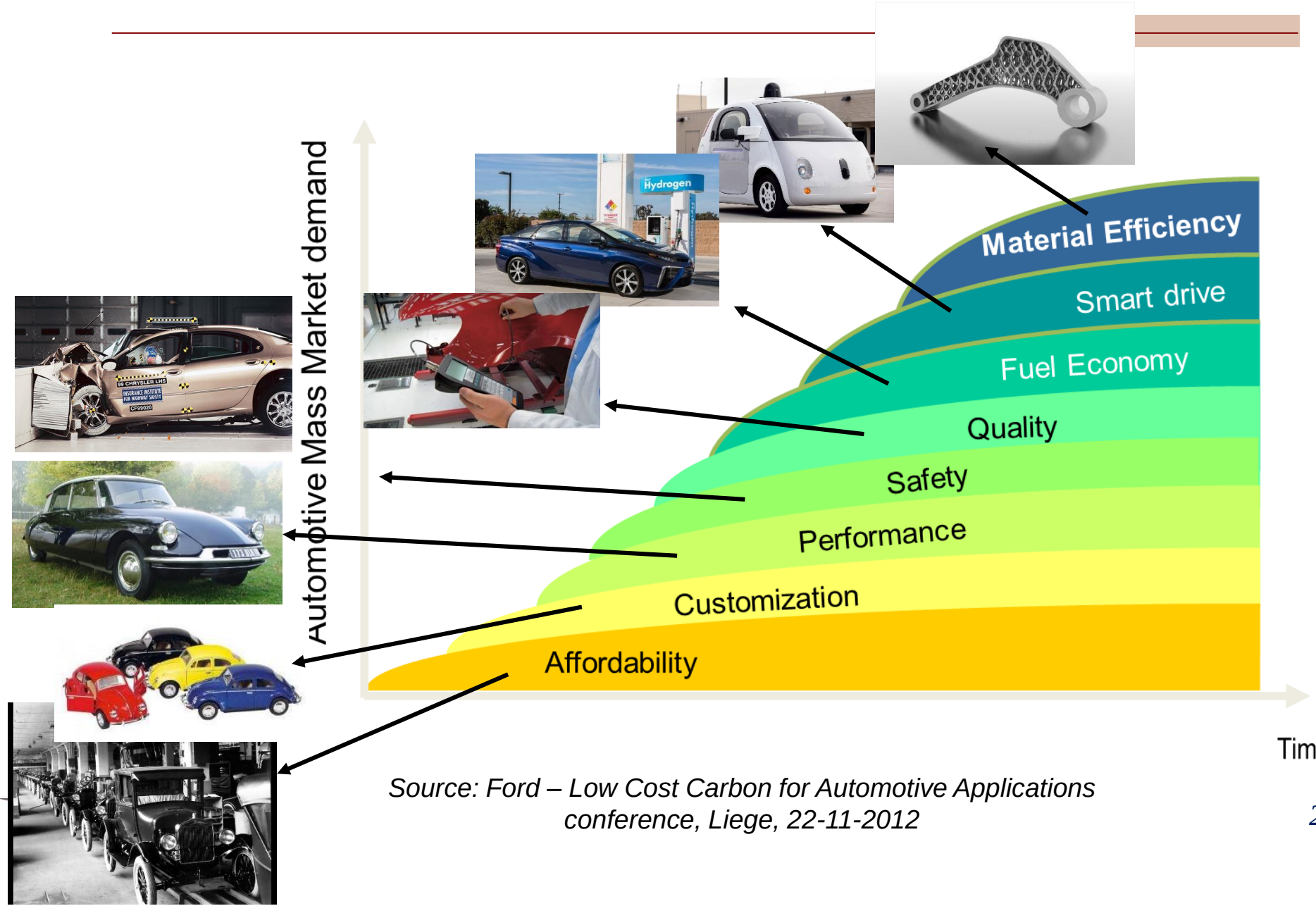
SHIFT IN POWERTRAIN TECHNOLGIES



Source: VALEO

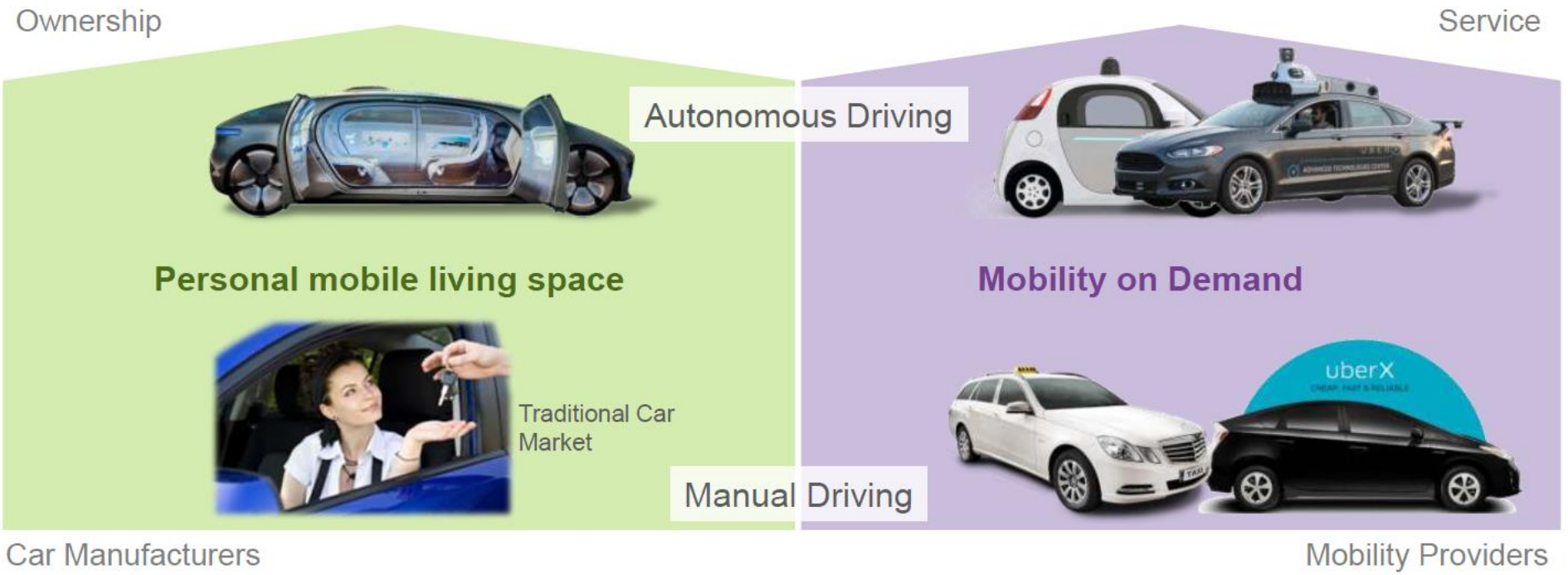
- Powertrain shift:
  - Diesel drops but remains for low cost and long haul vehicles
  - CNG and LNG provide an alternative fuel route
  - EV gaining momentum first for urban applications waiting for new batteries
  - Plug-In Hybrid Vehicles for premium

CHALLENGES IN AUTOMOTIVE INDUSTRY



Source: Ford – Low Cost Carbon for Automotive Applications conference, Liege, 22-11-2012

CHANGING INDIVIDUAL MOBILITY



- Mobility and ownership models will diversify
- New players are emerging

QUESTIONS

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