Visions, challenges and trends Automotive Sector Propulsion systems

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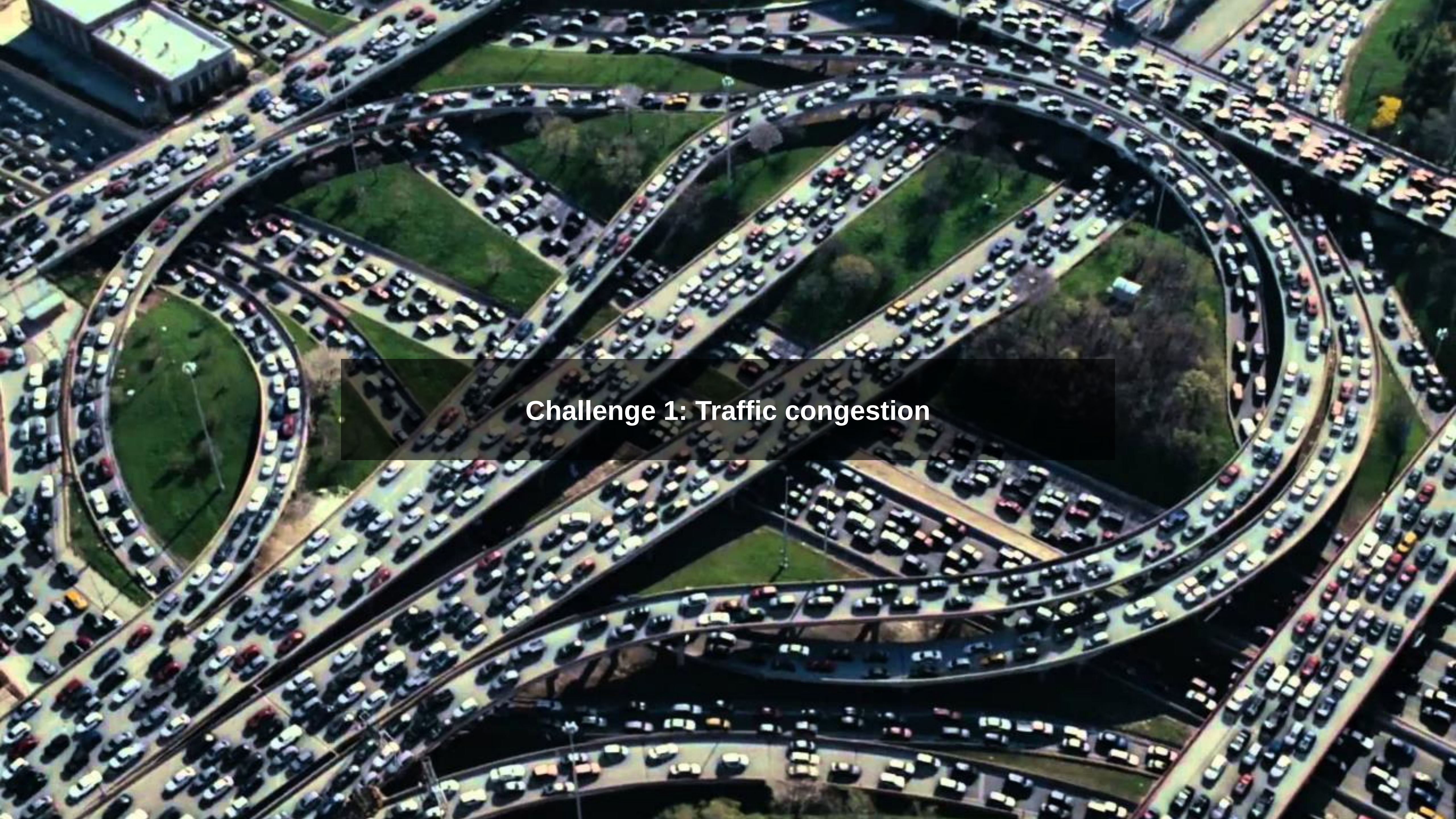
Introduction

Societal changes


Challenge 1: Traffic congestion

Challenge 2: Pollution

Challenge 3: Liveability

Introduction

Automotive Challenges

What are the challenges of automotive engineering?

Safety
Seamless mobility
Sustainability

These challenges are not new

Introduction

Technological solutions

What are the solutions?

Automation
Connectivity
Electrification
Energy efficiency
Sharing

Synergy brings success

Technologies impacting the automotive industry

Recent technological trends, such as artificial intelligence, IoT and robotics, are applied in the automotive sector. These technological advances enable car companies to produce self-driving cars and offer multiple solutions. Some of these solutions include technologies associated with industrial resilience, digital society or green transformation.

Materials

- Frontier and sustainable materials
- Microelectronics and nanoelectronics
- Semiconductors

Advanced industry

- Automation
- Additive manufacturing
- Robotics and collaborative robotics
- Simulation

New digital economy

- Insurtech
- New space

Smart City
Mobility of the future

- Electric/micromobility vehicle
- Connected vehicle

Digitisation

- IoT/sensors
- Immersive technologies
- DLT/blockchain
- Big data + artificial intelligence
- Photonics/quantum computing
- Cybersecurity
- Connectivity
- Cloud

Processes

- Chemical recycling

Energy

- Clean energies
- Batteries and storage
- Hydrogen

Circularity

- Decarbonisation/CO_2 capture and use

Industrial resilience
Digital society
Green transformation

Source: *ACCIÓ*

Maturity	CONNECTED	AUTONOMOUS	SHARED	ELECTRIC
Technology Readiness	■ Technical focus shifts to provide superb driver experience	● No insurmountable technical hurdle to prevent introduction	■ Connectivity/autonomy will boost sharing	◆ EV technology rivalling internal combustion engines decade(s) away
Ecosystem Infrastructure Readiness	◆ New infrastructure players are expected to enter	● Standardized vehicle-to-everything infrastructure needs to be built	◆ New players will enter targeting integration	◆ Funding required to build charging infrastructure
Legal/Regulatory Framework Availability	◆ Industrywide standards required for vehicle-to-everything protocols	○ Liability exposure of stakeholders must be defined	◆ Consumer laws are missing for the sharing economy	◆ Global standards are required for infrastructure
Profitable Business Model Availability	● Highest roadblock is prohibitive vehicle-to-everything investment	◆ Expect a few losers (taxi) but for many, game change	◆ No dominant business model yet; rental company joint ventures promising	◆ Without step change in EV technology, no viable business model
Consumer Behavior	■ If no original equipment solution, customers opt for aftermarket ones	● A number of consumer hurdles must be addressed	● Lower costs will put non-drivers in shared cars	◆ Without subsidies, EVs attract limited buyers
Vehicle OEM Readiness	● Choice of delivery strategy/platform, key for OEM	● Luxury OEMs seem better positioned	◆ OEM experimenting outside business model will grow	◆ EVs have potential to uproot the current business model

Maturity level
○ <25%
◆ 25 – 50%
● 50 – 75%
■ > 75%

Source: AlixPartners, LLP

Introduction

Moment of truth

GENERATION Z:
CONNECTED FROM BIRTH.

Introduction

Who we are?

The mobility sector, segmentation of the sector

Rail	Automotive	Motorcycle	Micromobility	Others
Passenger transport (long distance, medium distance, suburban, metro, section and light trains))	Passenger cars	Motorcycles	Bicycles, tricycles and Electric motorbikes	Bus
Transport of goods	Light commercial vehicles (derived from tourism, pick-ups and vans)	Moped	PMV Personal Mobility Vehicles (scooters, skateboards, skates, segways, hoverboards, solowheels, light vehicles for reduced mobility, etc.)	Maritime transport
	Industrial Vehicles (light, heavy industrial and tractor trucks)	Other light vehicles (tricycles, quadricycles)		Air transport

Mobility services

Source: *ACCIÓ and IDOM*

Description of the automotive industry value chain

Suppliers of raw materials

(steel, metals, polyurethane, coating chemicals, plastics, etc.)

TIERS 1, 2 and 3

Battery suppliers

Automation and connectivity providers

OEM manufacturers

Logistics

Distribution, imports and exports

Car dealers

Users

Mobility as a service

After-sales service

Services for users

Engineering and services for companies (certification companies, etc.)

Technology and R&D centres

Associations, trade fairs and congresses

Universities and training centres

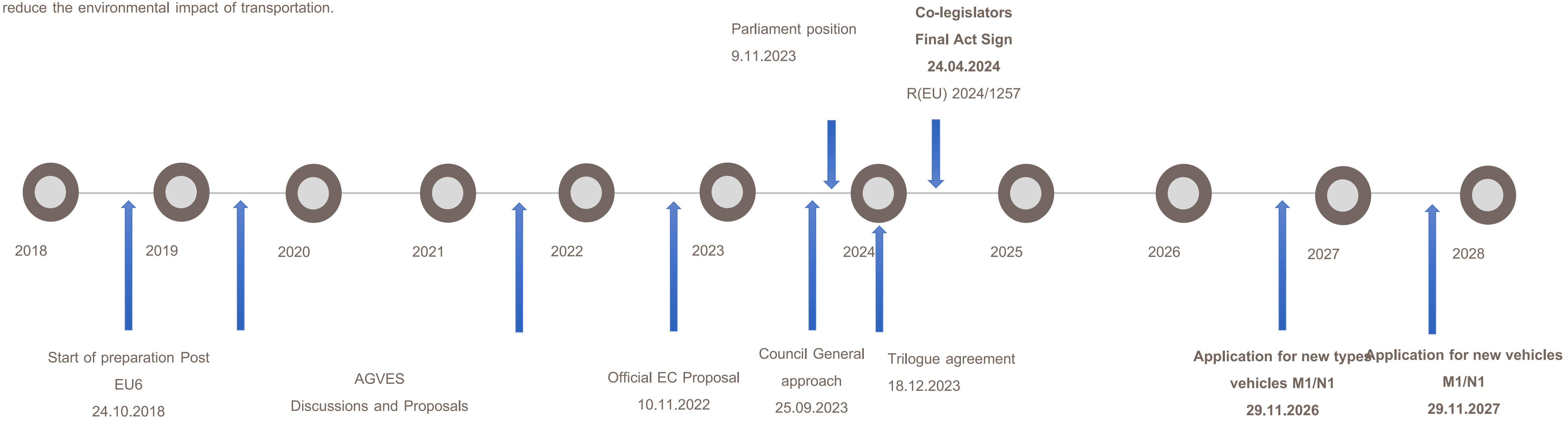
Source: *ACCIÓ.*

Roadmaps

Electrification & energy eficiency

Impact on Industry: The new standards will likely require automotive manufacturers to develop and implement new technologies to meet these stricter limits.

Environmental Goals: This regulation aligns with broader EU efforts to improve air quality and reduce the environmental impact of transportation.



AGVES: Advisory Group on Vehicle Emission Standards (European Commission)

- New pollutants regulated
- Extension of the vehicle durability
- Introduction of durability requirements on electric and hybrid vehicles
- New testing procedure and particle emissions limits from brakes
- Intention to limit particle emissions from tyres (tyre abrasion)
- Control systems emissions on the vehicles: On Board Monitoring Systems
- Antitampering
- One legislation for both LDV and HDV



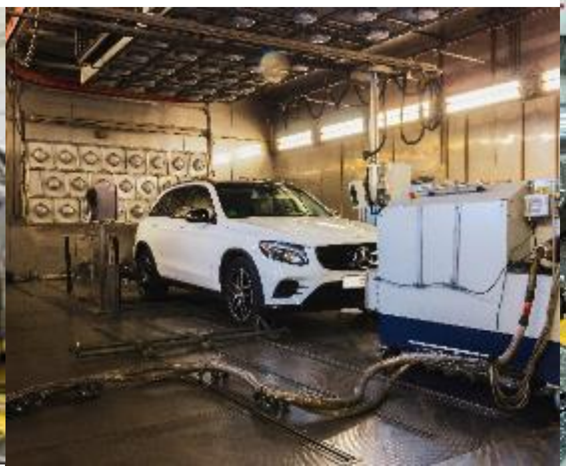

Exhaust emissions for Light Duty Vehicles

- New pollutant: PN10 (particle size 10nm instead of the actual 23nm)

  Same limits than EURO 6

  Same limit than PN23 for the new PN10

- For Laboratory and RDE testing
- No changes in procedures



Evaporatives Emissions

- New limit
- No changes in procedures

	EURO 7	EURO6d
Hot soak + 2DD test	1,5 g	2 g




COLD EMISSIONS TYPE 6 (-7°C)

Applying to all powertrains: ICE, HEV and PEV

DURABILITY

- Extension vehicle durability (combustion engine):

Lifetime	M1, N1 and M2
Main lifetime	Up to 160 000 km or 8 years
Additional lifetime	Up to 200 000 km or 10 years

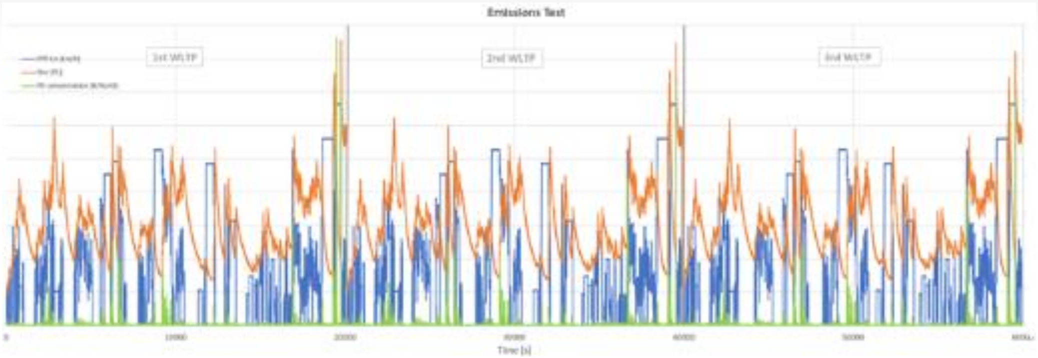
- New requirement vehicle durability for battery vehicles (hybrids and electrics)

Minimum Performance Requirement	
Battery energy capacity	80% - 5years or 100 kkm
(in vehicle battery durability)	72% - 5-8 years or 100-160 kkm
Electric Range	Declaration for the moment. TBD




PARTICLE EMISSIONS BRAKES

- Completely new procedure
- Test on component level for a vehicle limit level



TPN_{10} , SPN_{10} and $PM_{2,5}$ limit TBD, for the moment only declaration

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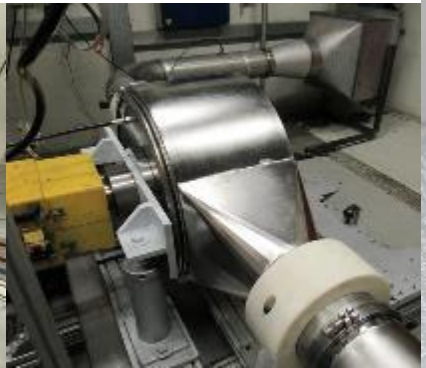
PM_{10} limits (depending on powertrain):

- CE until 2034 — 7 mg/km
  ICE, as of 2035 — TBD mg/km
- FCV & HEV until 2029 — 7 mg/km
  FCV & HEV, as of 2030 — TBD mg/km
- PEV until 2029 — 3 mg/km
  PEV as of 2030 — TBD mg/km



PARTICLE EMISSIONS TYRES

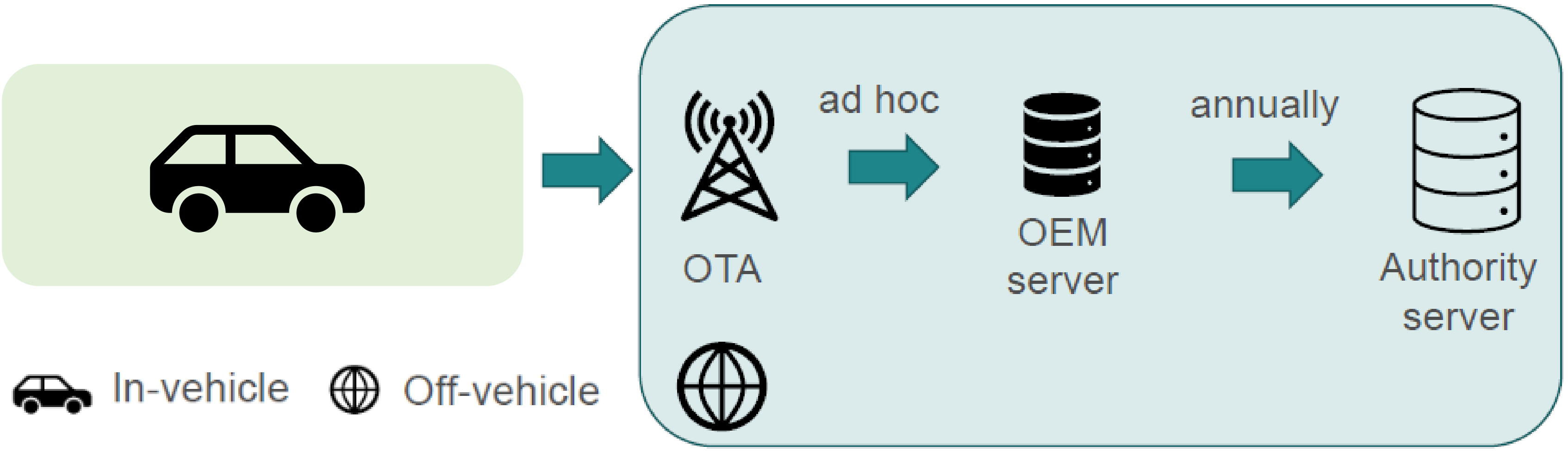
- Completely new procedure

Tyre abrasión rate
Limit (TBD)

- Procedure under development on UNECE
- Initial proposal in UNR117, two options proposed:
  - Convoy method: on road testing in real driving conditions - 8.000km. Reference vehicle with reference tyres included
  - Drum method: test to be performed on a special drum with special surface to test the tyre following a cycle during 5.000km equivalent


On Board Monitoring

- New System
- OEM's compliance declaration and demonstration
- Monitoring of NOx & PM during vehicle useful life
- Final procedure and requirements under development

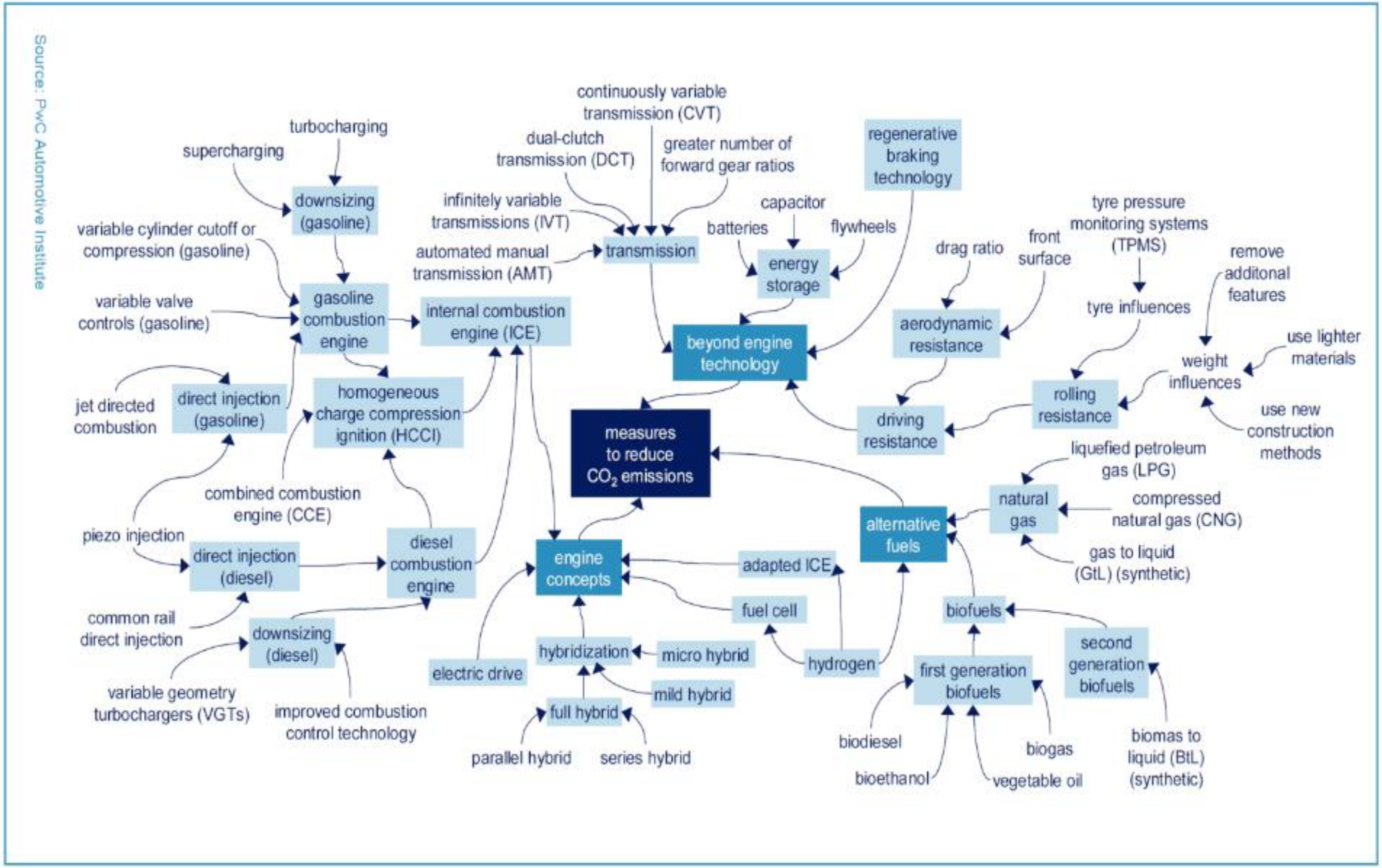


ANTITAMERING

- All proposals, stricter requirements during whole vehicle's life:

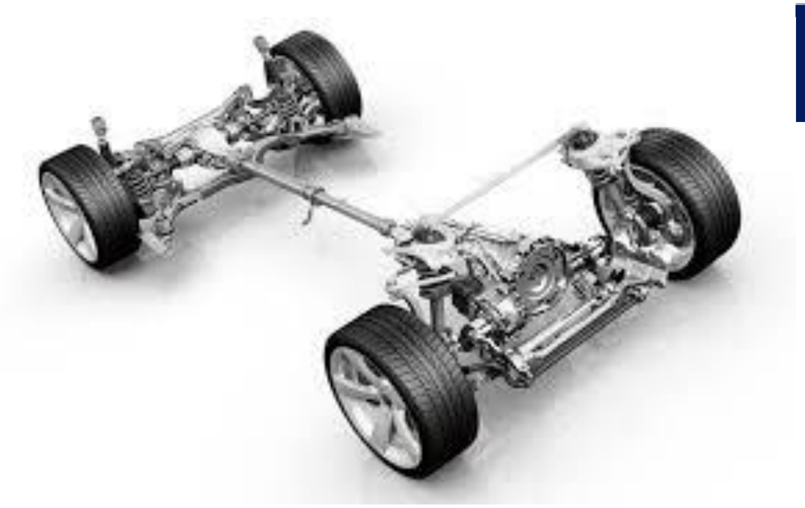
Manufacturers shall not design, construct and assemble vehicles with manipulation devices or manipulation strategies, which cause a non-compliant vehicle to appear compliant with this Regulation.

Manufacturers shall design, construct and assemble vehicles in such a way to minimise vulnerabilities, arising in all phases of their life-cycle, that may lead to tampering



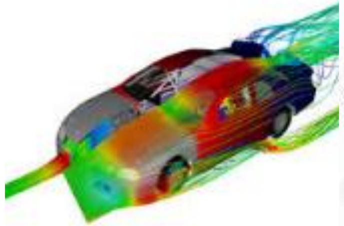
Source: PwC Automotive Institute
measures to reduce CO_2 emissions
internal combustion engine (ICE)
gasoline combustion engine
downsizing (gasoline)
turbocharging
supercharging
variable cylinder cutoff or compression (gasoline)
variable valve controls (gasoline)
direct injection (gasoline)
jet directed combustion
piezo injection
homogeneous charge compression ignition (HCCI)
combined combustion engine (CCE)
diesel combustion engine
direct injection (diesel)
common rail direct injection
downsizing (diesel)
variable geometry turbochargers (VGTs)
improved combustion control technology
transmission
continuously variable transmission (CVT)
dual-clutch transmission (DCT)
greater number of forward gear ratios
infinitely variable transmissions (IVT)
automated manual transmission (AMT)
beyond engine technology
energy storage
capacitor
batteries
flywheels
regenerative braking technology
aerodynamic resistance
drag ratio
front surface
driving resistance
rolling resistance
tyre influences
tyre pressure monitoring systems (TPMS)
weight influences
remove additonal features
use lighter materials
use new construction methods
engine concepts
electric drive
hybridization
micro hybrid
mild hybrid
full hybrid
parallel hybrid
series hybrid
adapted ICE
fuel cell
hydrogen
alternative fuels
natural gas
liquefied petroleum gas (LPG)
compressed natural gas (CNG)
gas to liquid (GtL) (synthetic)
biofuels
first generation biofuels
second generation biofuels
biodiesel
bioethanol
biogas
vegetable oil
biomas to liquid (BtL) (synthetic)

POWERTRAIN



measures
to reduce
CO_2 emissions

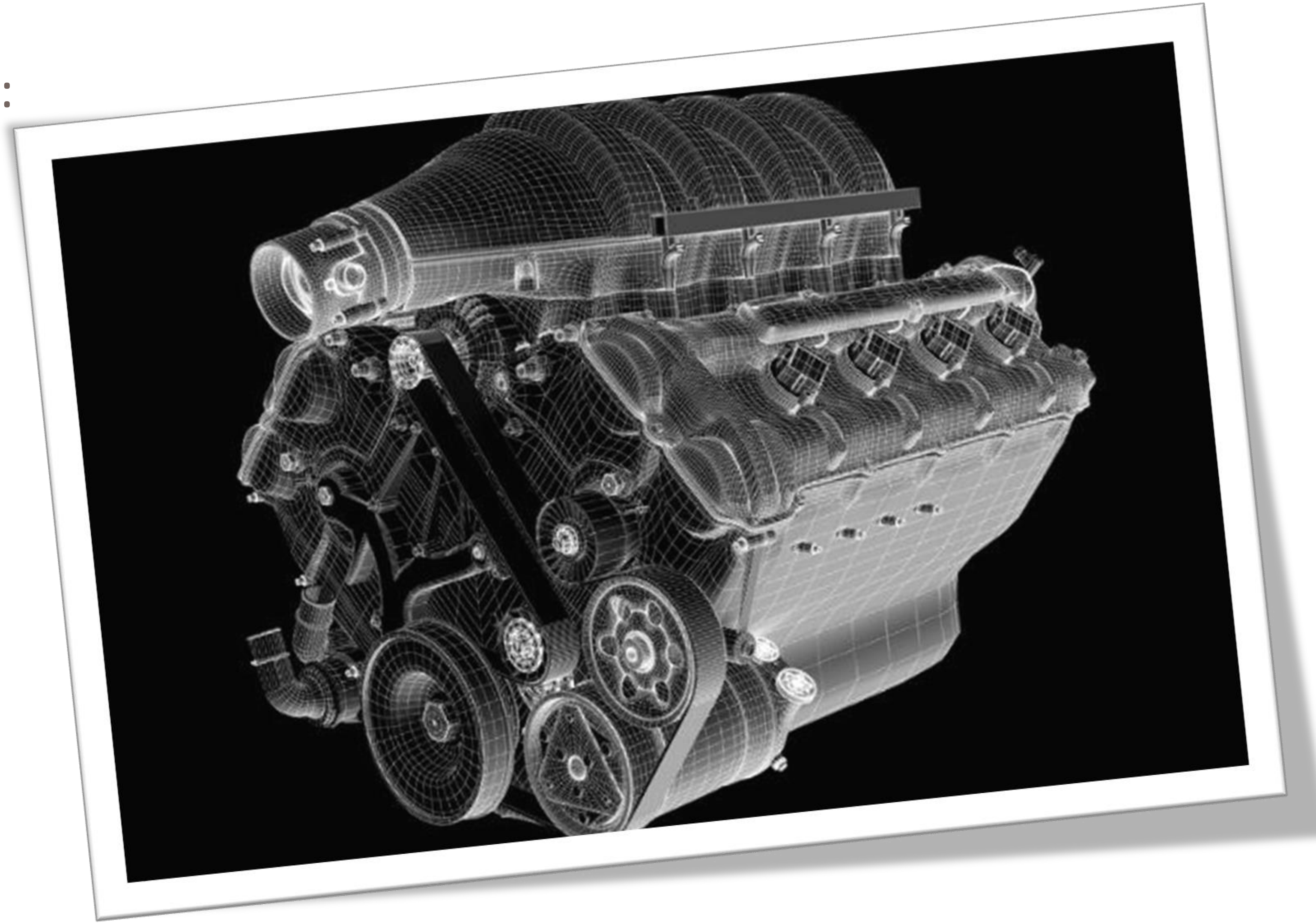
FLUID DYNAMICS
LIGHTWEIGHT & WEIGHT MANAGEMENT
ROLLING RESISTANCE



1.Internal Combustion Engines (ICE):

a) Gasoline (Petrol) Engines:

- Use gasoline as fuel
- Operate on the Otto cycle
- Ignition via spark plugs
- Generally higher RPM and lower torque compared to diesel
- Common in passenger cars
- Pros: Responsive, quieter operation
- Cons: Lower fuel efficiency compared to diesel



1.Internal Combustion Engines (ICE):

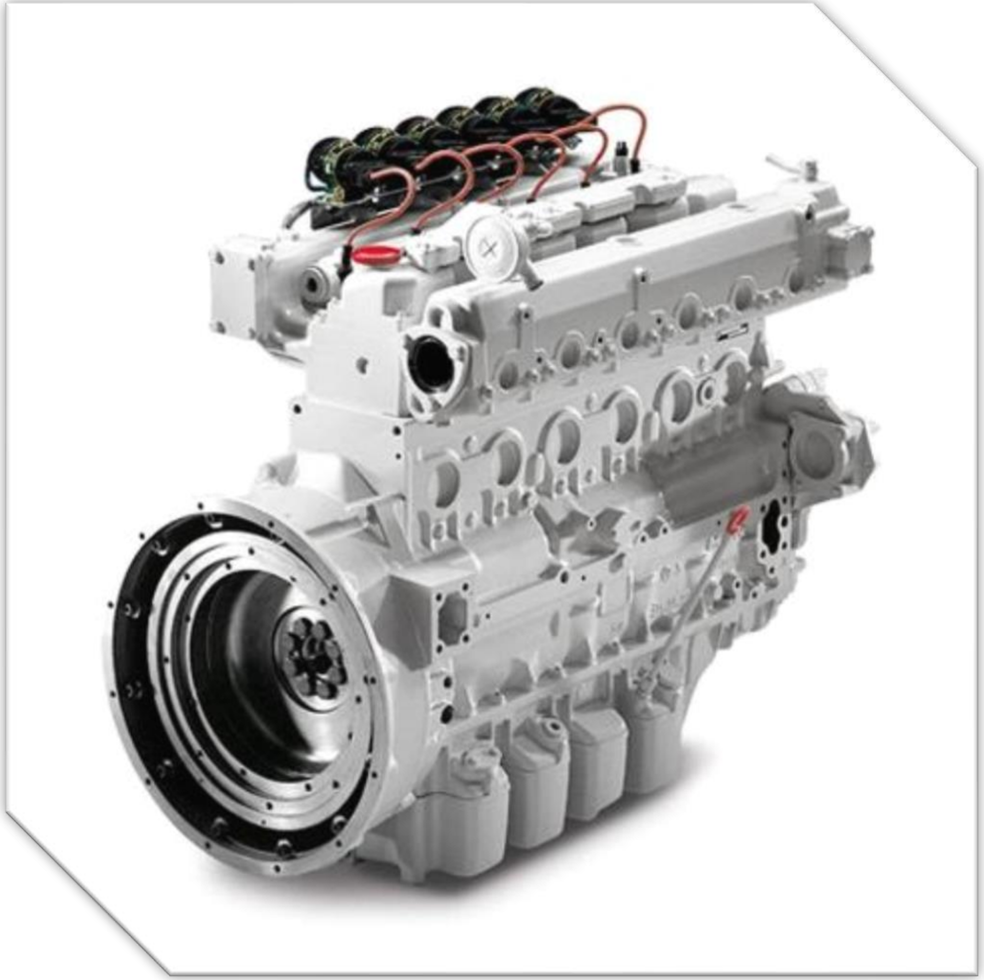
b) Diesel Engines:

- Use diesel fuel
- Operate on the Diesel cycle
- Compression ignition (no spark plugs)
- Higher torque at lower RPM
- Common in trucks, SUVs, and some passenger cars
- Pros: Better fuel efficiency, higher torque
- Cons: Higher emissions of particulate matter and NOx

1.Internal Combustion Engines (ICE):

c) Compressed Natural Gas (CNG) Engines:

- Use natural gas stored in high-pressure tanks
- Can be dedicated CNG or bi-fuel (CNG and gasoline)
- Lower emissions compared to gasoline and diesel
- Pros: Cleaner burning, lower fuel costs
- Cons: Less widely available fuel infrastructure



1.Internal Combustion Engines (ICE):

d) Liquefied Petroleum Gas (LPG) Engines:

- Use a mixture of propane and butane
- Often converted from gasoline engines
- Lower emissions than gasoline
- Pros: Lower fuel costs, cleaner burning
- Cons: Slightly lower power output, reduced trunk space due to fuel tank

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1. Internal Combustion Engines (ICE):

e) Hydrogen Engines:

- Basic Concept: H2ICEs are similar to traditional gasoline engines but use hydrogen as fuel instead.
- Operation: Hydrogen is injected into the engine and ignited with a spark plug. The combustion process produces energy to power the vehicle.
- Key Features: Near-zero emissions (mainly water vapor). High efficiency due to hydrogen's wide flammability range. Potential for quick refueling
- Advantages: Significantly reduced carbon footprint, especially if hydrogen is produced from renewable sources. Utilizes existing engine manufacturing infrastructure
- Challenges: Hydrogen storage and distribution infrastructure. Lower energy density by volume compared to gasoline. Current hydrogen production methods are not always carbon-neutral
- Modifications: Adapted fuel injection and ignition systems. Materials chosen to prevent hydrogen embrittlement.
- Current Status: Less common than hydrogen fuel cell vehicles. Some ongoing research, particularly for heavy-duty applications

1. Definition:
   - **Synthetic fuels** (synfuels) are liquid fuels produced from carbon, natural gas, or biomass. They are chemically engineered to mimic the properties of conventional fuels
2. Production Process:
   - Fischer-Tropsch synthesis: Converts carbon monoxide and hydrogen into liquid hydrocarbons
   - Methanol-to-gasoline process
   - Direct fuel synthesis using renewable energy (Power-to-X)
3. Types of Synthetic Fuels:
   - Synthetic gasoline
   - Synthetic diesel
   - e-fuels (electrofuels)
4. Advantages:
   - Can be used in existing internal combustion engines without modification
   - Potential for lower emissions compared to conventional fossil fuels
   - Can be produced using renewable energy sources
   - Helps in energy security and reducing dependence on oil imports

5. Challenges:
   5. High production costs
   6. Energy-intensive manufacturing process
   7. Competition with direct electrification in transport sector

6. Environmental Impact:
   1. Potential for carbon neutrality if produced using renewable energy and captured CO_2
   2. Reduced particulate matter and sulfur emissions

7. Applications:
   1. Automotive industry
   2. Aviation (sustainable aviation fuels)
   3. Shipping

8. Current Status:
   1. Increasing interest from automotive and aviation industries
   2. Pilot projects and small-scale production in several countries
   3. Part of the EU's strategy for decarbonizing transport

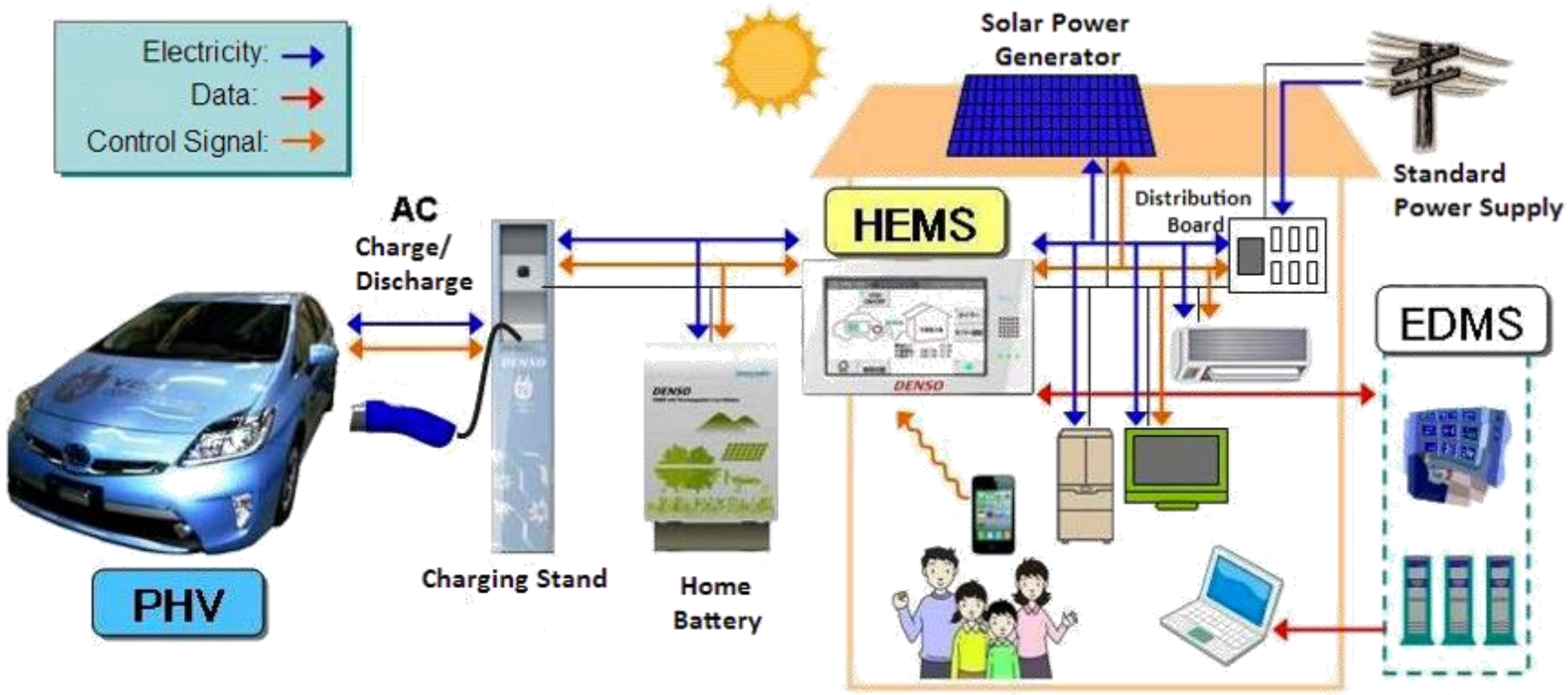
9. Future Outlook:
   1. Ongoing research to improve production efficiency and reduce costs
   2. Potential role in hard-to-electrify sectors
   3. Debates about their place in a carbon-neutral future

2. Electric Motors:
    - Powered by electricity stored in batteries
    - No direct emissions from the vehicle
    - Use of regenerative braking to recover energy
    - Pros: Zero direct emissions, quiet operation, low maintenance
    - Cons: Limited range, longer refueling (charging) times, cost

TESLA


VOLKSWAGEN


Volkswagen


Electricity:
Data:
Control Signal:
AC
Charge/
Discharge
PHV
Charging Stand
Home
Battery
Solar Power
Generator
HEMS
Distribution
Board
Standard
Power Supply
EDMS

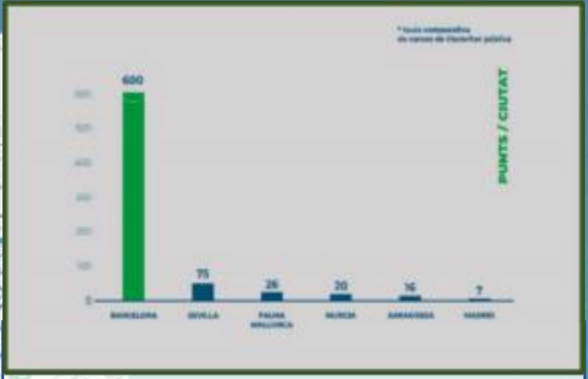
ENDOLLA BARCELONA

860 EVCS
(8,6 EVCS/km2)

809 off street
+ 51 QC on street

1,26kW/eCar

+ 12.000 uses/month
+ 18.000 registered users



2013-2020 Inversió acumulada 5 M€
2021-2024 Inversió prevista 12M€

Aparcaments B:SM

Al carrer

BUT!!! Increasing Demand needs x2 infrastructure every 2 years aprox.

3. Hybrid Powertrains:

a) Conventional Hybrid:

- Combines an internal combustion engine with an electric motor
- Battery charged through regenerative braking and the ICE
- Improved fuel efficiency over traditional ICE vehicles
- Pros: Better fuel economy, especially in city driving
- Cons: More complex system, higher initial cost

b) Plug-in Hybrid (PHEV):

- Similar to conventional hybrid but with larger batteries
- Can be charged from an external power source
- Allows for short all-electric driving ranges
- Pros: Combines benefits of electric and ICE vehicles
- Cons: Higher cost, complexity

4. Hydrogen Fuel Cell:
    - Uses hydrogen to generate electricity, which powers an electric motor
    - Produces only water vapor as emission
    - Requires hydrogen refueling infrastructure
    - Pros: Zero emissions, quick refueling compared to battery electric
    - Cons: Limited hydrogen infrastructure, high production costs

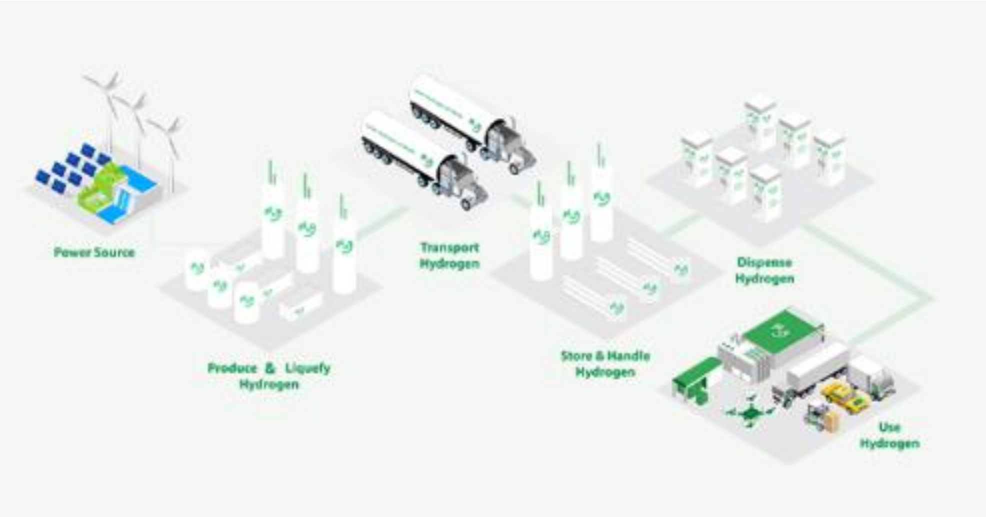
USA

2024
$7 billions

PLUG POWER
Bloomenergy

Electrolizers

Fuel cells



EUROPE

Comisión Europea

2024
€17 billions
80 hydrogen projects

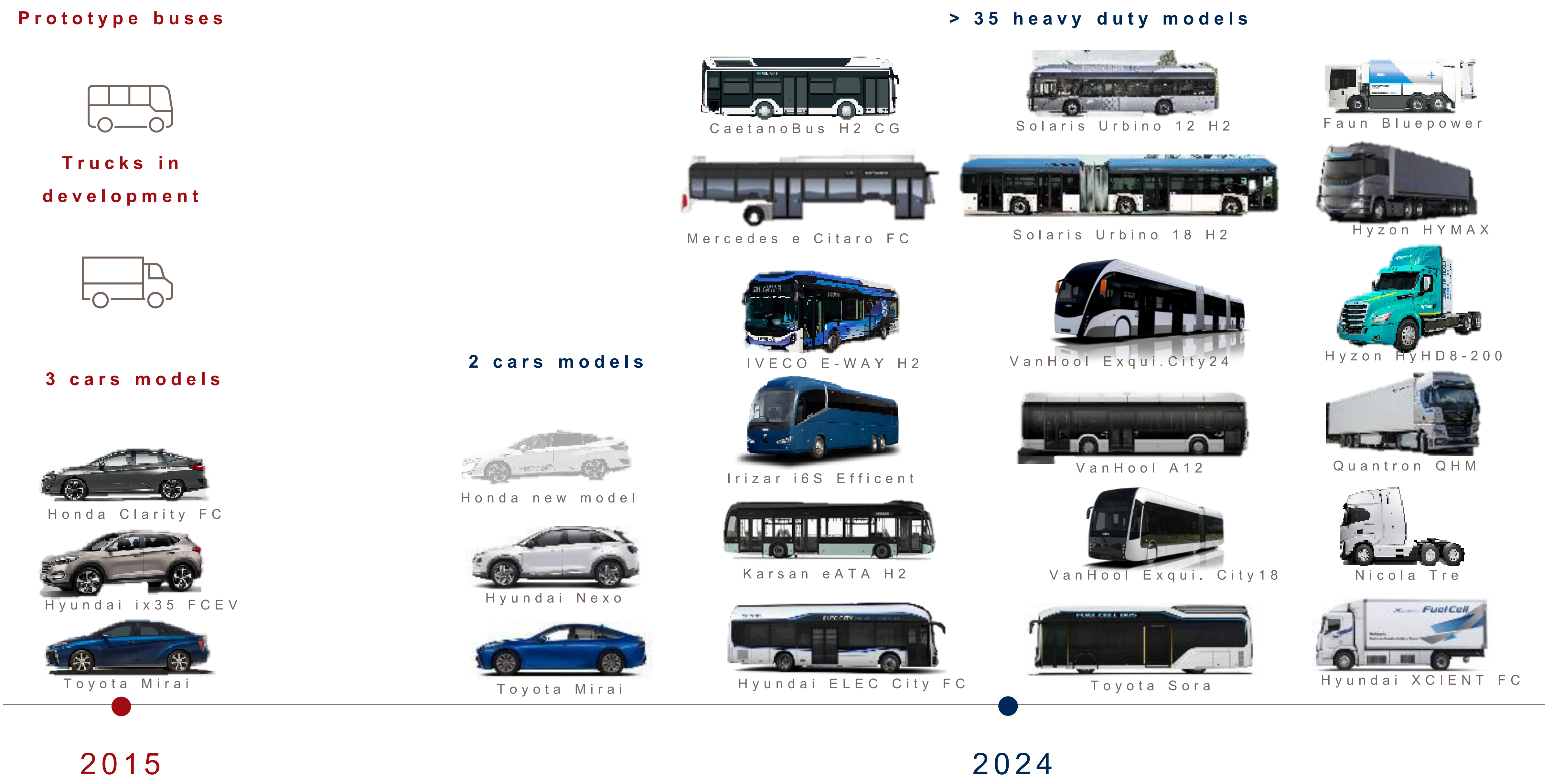
BOSCH

2024
€2,5 billions

EKPO

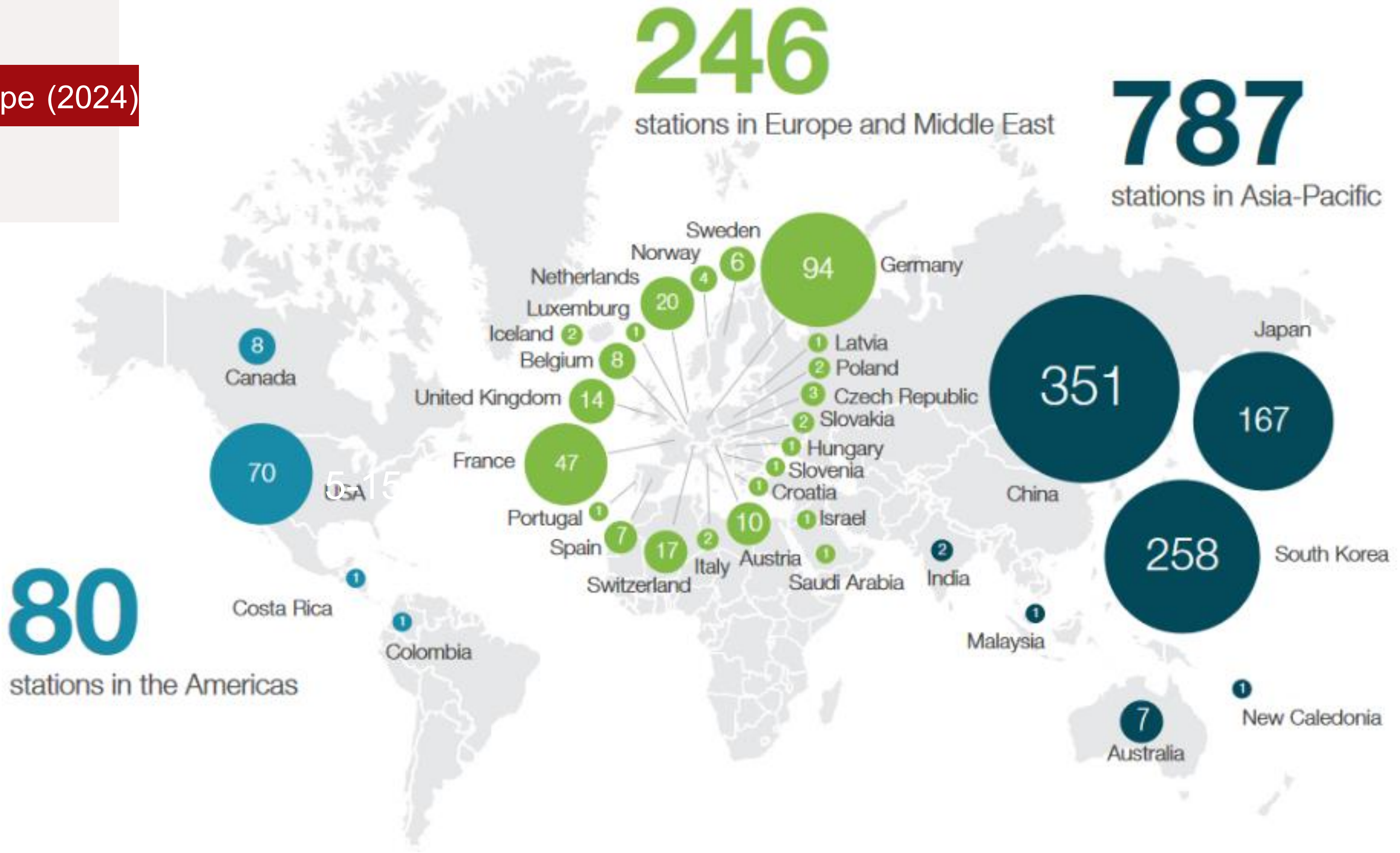
2024
€177 millions

BMW
TOYOTA

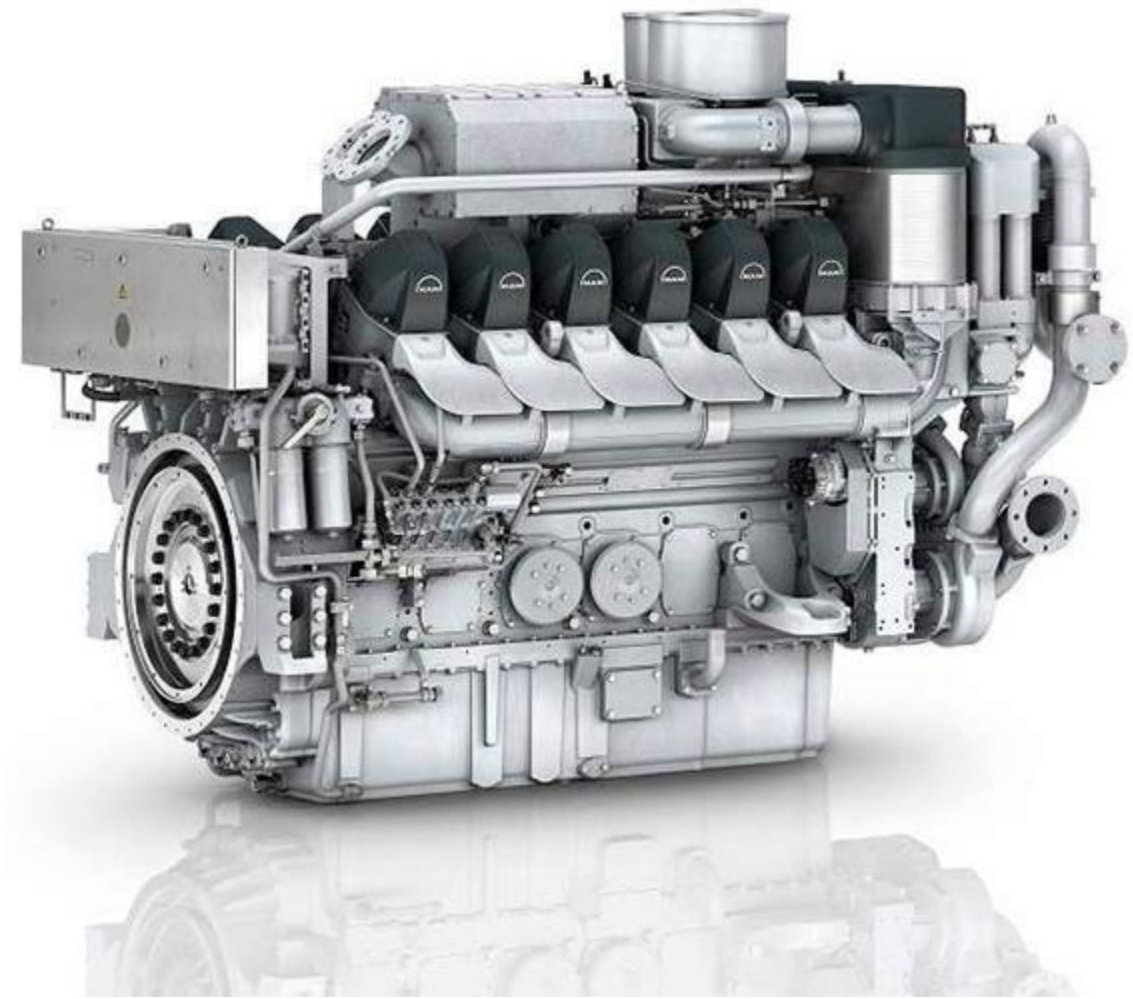

Prototype buses
Trucks in development
3 cars models
Honda Clarity FC
Hyundai ix35 FCEV
Toyota Mirai
2 cars models
Honda new model
Hyundai Nexo
Toyota Mirai
> 35 heavy duty models
CaetanoBus H2 CG
Mercedes e Citaro FC
IVECO E-WAY H2
Irizar i6S Efficent
Karsan eATA H2
Hyundai ELEC City FC
Solaris Urbino 12 H2
Solaris Urbino 18 H2
VanHool Exqui.City24
VanHool A12
VanHool Exqui. City18
Toyota Sora
Faun Bluepower
Hyzon HYMAX
Hyzon HyHD8-200
Quantron QHM
Nicola Tre
Hyundai XCIENT FC
2015
2024

Limited infrastructure

~200 HRS in Europe (2024)



5. Biofuel Engines:
   - Can use fuels derived from organic materials
   - Common biofuels include bioethanol and biodiesel
   - Often blended with conventional fuels
   - Pros: Renewable source, can reduce overall carbon emissions
   - Cons: Potential competition with food crops, variable availability



6. Compressed Air Engines:

- Use compressed air stored in tanks to power the engine
- Limited commercial applications
- Pros: Zero direct emissions, potential for quick refilling
- Cons: Limited range, energy losses in air compression

Life Cycle Assessment (LCA)

1. LCA Overview:
   - Evaluates environmental impact from production to end-of-life
   - Considers: raw material extraction, manufacturing, use phase, and disposal/recycling
2. LCA Findings:
   - BEVs: Lower use-phase emissions, higher production emissions
   - ICE vehicles: Higher use-phase emissions, lower production emissions
   - HEVs/PHEVs: Intermediate between ICE and BEV
   - FCEVs: Dependent on hydrogen production method
3. Current European Regulations:
   - Euro 6d emission standards for ICE vehicles
   - CO2 emission targets for new car fleets
   - Incentives for low and zero-emission vehicles
4. Future European Regulations:
   - Euro 7 standards (from 2025): Stricter emission limits, including non-exhaust emissions
   - Proposed ban on new ICE vehicle sales by 2035
   - Emphasis on Well-to-Wheel and Life Cycle emissions LCA in Regulations:
   - Growing focus on full life cycle emissions in policy-making
   - Consideration of production and end-of-life impacts, not just tailpipe emissions
   - Push for sustainable battery production and recycling for EVs
5. Challenges:
   - Balancing immediate air quality concerns with long-term climate impact
   - Ensuring a clean energy mix for BEV benefits
   - Addressing emissions from tire and brake wear
6. Future Outlook:
   - Holistic approach combining LCA with air quality and climate goals
   - Potential regulations on battery production and recycling
   - Increased support for renewable energy in transport sector

Thank you very much for your attention