AutoEvent 2021 FOR AUTOMOTIVE INDUSTRY

PIM POLSKA IZBA MOTORYZACJI założona w 1994 r.

AUTO EVENT 2021 - DEBATA

Europejska Motoryzacja - „Carmageddon” czy „Transformers”?

Analiza wpływu propozycji Komisji Europejskiej „Fit for 55” i Euro 7/VII na rozwój układów napędowych pojazdów w Unii Europejskiej

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Early light-duty vehicle development

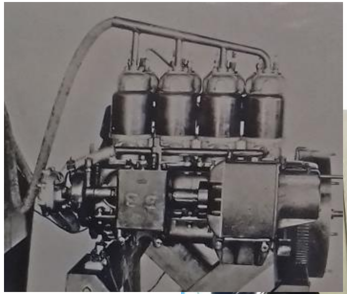
- Electric vehicles appeared in late 1860s - **earlier than internal combustion engines** (ICE 1876).
- Popularity was **boosted** by **low maintenance** as they **does not require complicated start procedures** or preheating, and had no emissions.
- 1888 - first four wheeled electric car is developed by A. Flocken.
- 1899 - the "La Jamais Contente" FR first electric vehicle which **exceeded 100 km/h**.
- 1900 - electric vehicles **top selling** road vehicles in US with **28%** of the market.

Detroit Electric Brougham: Early electric urban mobile

Specifications

1918 Detroit Electric Brougham Price, new: $ 2940; Wheelbase: 100 in
Engine: Electric, DC current; **Suspension:** Front - semi-elliptic leaf springs
Rear - semi-elliptic leaf springs; **Brakes:** Drums, mechanically operated on rear wheels

Early light-duty vehicle development




Source: SAE Congress 2018

1912 Cadillac Model 30

Specifications

1912 Cadillac Model 30

Price, new: $ 1800

Wheelbase: 116 in

Engine

V-8 CID, L-head

Power: 40 HP, Bore: 4.5”, Stroke: 4.5”

Splash lubrication

Transmission – 3 speed manual, no synchronizers

…and from that point, the **EV era ended**,

…do you know why?

Energy security vs. GHG (CO_2) emissions reduction is an ever-present consideration

POLICY

- International security
- National security
- Public policy
- Environmental policy

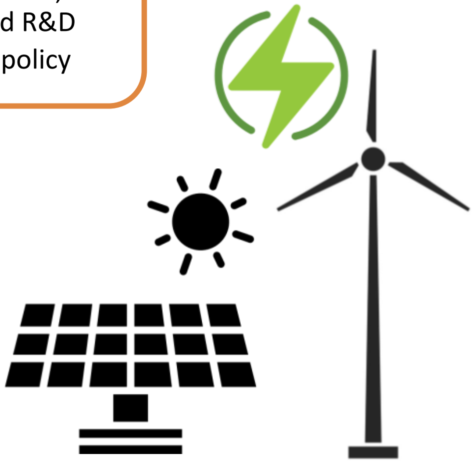
ECONOMY

- International prices
- Investment regimes
- Sustainable development

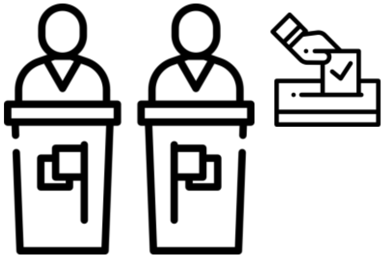
ENERGY

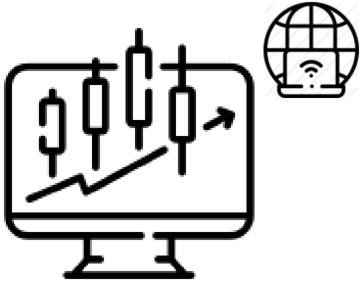
- Energy mix
- Renewable energy usage
- Energy infrastructure
- Energy efficiency
- Energy innovations, technologies and R&D
- Environmental policy

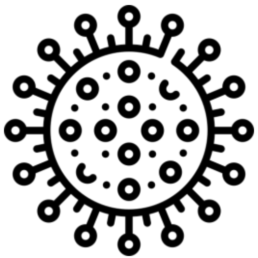
ENERGY SECURITY or GHG emissions reduction?



Main drivers of powertrain and fuel development, megatrends: Energy security and GHG emissions

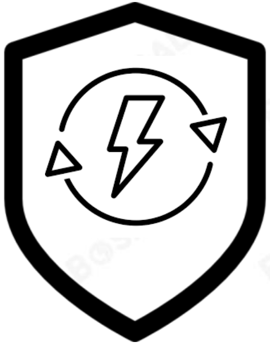


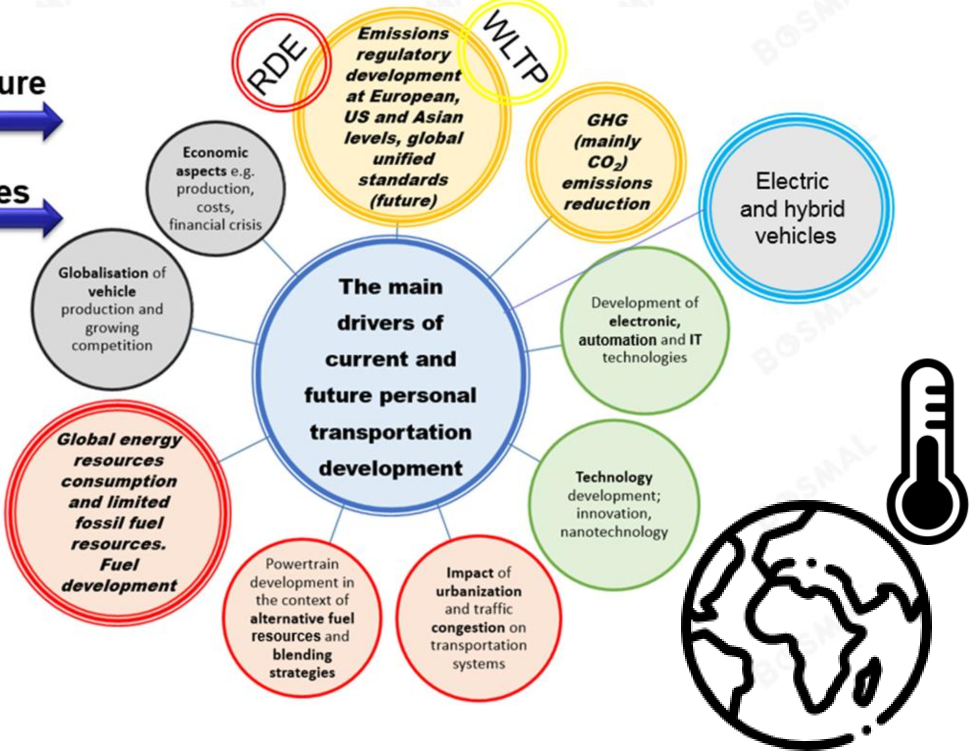




Political pressure

Financial issues





The European Green Deal

The Green Deal aims for ZERO net GHG emissions by 2050

- Strategy for Sustainable and smart mobility
- Revise the CO_2 emissions performance legislation for light duty vehicles by June 2021
- Extend EU's Emissions Trading to the maritime sector, and reduce the free allowances for airlines by June 2021
- Support public charging points: 1 million by 2025
- Boost the production and supply of sustainable alternative fuels for the different transport modes
- Review the Alternative Fuels Infrastructure Directive and the TEN-T Regulation in 2021
- **More stringent air pollutant emissions standards for combustion engine vehicles (Euro 7)**
- The plan targets 13 mln. electrically chargeable vehicles by 2025

Source: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

Średnie docelowe poziomy emisji CO_2 floty UE na lata 2025, 2030 i 2035- Fit for 55?

1 stycznia 2020 r. weszło w życie Rozporządzenie (UE) 2019/631 dotyczące PC i samochodów dostawczych

Najnowsza propozycja to 100% redukcja do roku 2035 – KONIEC ICE i HYBRYD w UE (???). Propozycja opublikowana 14 lipca 2021 r.

- **Parlament Europejski 24.06.2021 r. zatwierdził plan wprowadzenia wymogu 55% redukcji (wszystkie sektory) do 2030r. (obecny cel: 40%), i „celem osiągnięcia 90% redukcji emisji z sektora transportu do roku 2050”**
- W 2019 r. tylko emisja CO_2 (nie wszystkie GHG lub ekwiwalent CO_2) w UE = 7,7% globalnej emisji CO_2. Z tego 12% jest emitowane przez samochody osobowe (PC). Tak więc 0,077*0,012≈ 0,9% - udział PC w UE w globalnej emisji CO_2

EU fleet average CO_2 targets for 2035 – proposal in Fit for 55

Po miesiącach oczekiwań, w ramach prezentacji pakietu **Fit for 55,** 14 lipca 2021 opublikowano wniosek dotyczący rozporządzenia zmieniającego rozporządzenie (UE) 2019/631 w odniesieniu do zaostrzenia norm emisji CO2 dla nowych samochodów osobowych (PC) i nowych lekkich samochodów dostawczych (LCV)

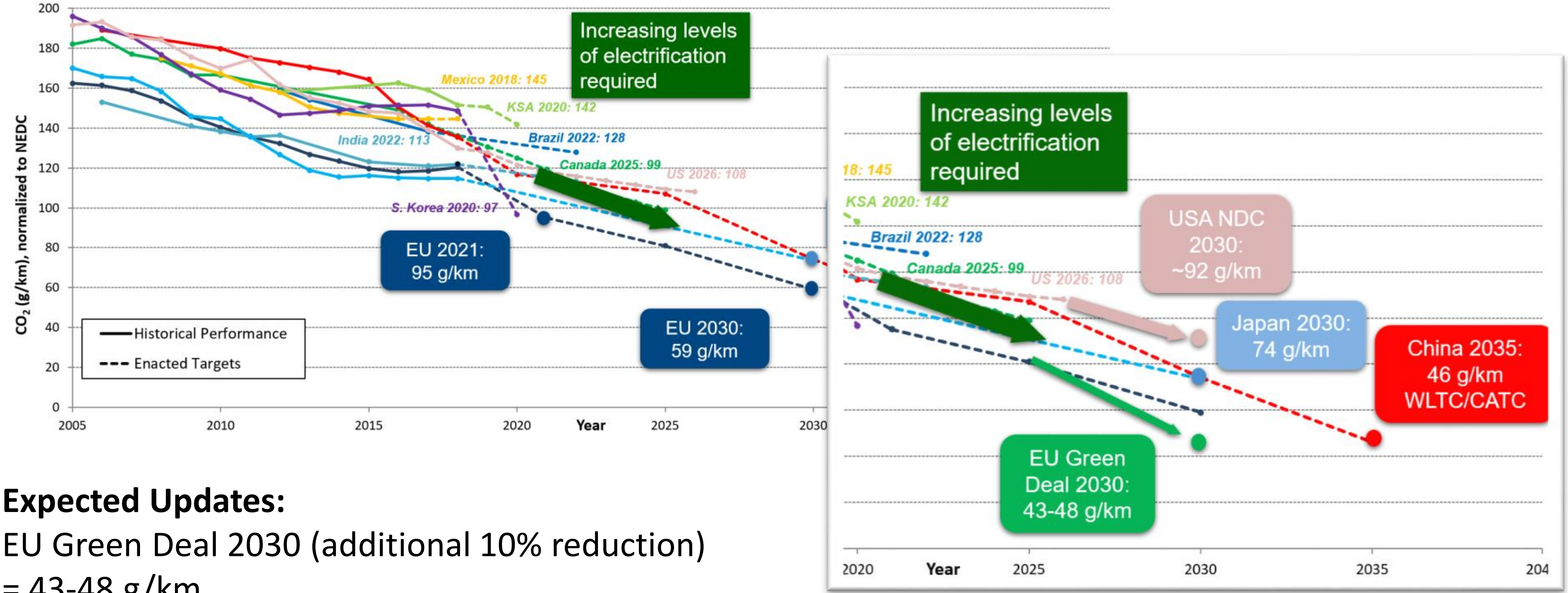
"Ogólnym celem niniejszego wniosku jest przyczynienie się do osiągnięcia neutralności klimatycznej do 2050 r. i w tym celu, zgodnie z europejskim prawem klimatycznym, przyczynienie się do osiągnięcia co najmniej 55% redukcji emisji gazów cieplarnianych netto do 2030 r. w porównaniu z 1990 r.
W art. 1 wprowadza się następujące zmiany:
a) w ust. 5 wprowadza się następujące zmiany: (i) w lit. a) liczbę "37,5 %" zastępuje się liczbą "55 %", (ii) w lit. b), liczbę "31 %" zastępuje się liczbą "50 %";
Od dnia 1 stycznia 2035 r. stosuje się następujące cele dla unijnego floty:
w odniesieniu do średnich emisji z nowego samochodowego pojazdu osobowego – cel dla unijnego taboru równy 100 % redukcji celu w 2021 r. określonego zgodnie z załącznikiem I pkt 6.1.3 część A;
w odniesieniu do średnich emisji z nowego floty lekkich samochodów dostawczych – cel dla unijnego taboru równy 100 % redukcji celu w 2021 r. określonego zgodnie z załącznikiem I pkt 6.1.3 część B.";

We wniosku wzywa się do ograniczenia celów (emisji CO2 z pojazdów) od 2030 r.:
Samochody osobowe: ~~-37,5%~~ **-55%**
Samochody dostawcze: ~~-31%~~ **-50%**
100% ograniczenia emisji CO2 od 2035 (TtW – WLTP)

Chociaż proponowany tekst nie wzywa wyraźnie do wprowadzenia zakazu stosowania jakiegokolwiek układu napędowego lub rodzaju paliwa, proponowany wymóg na 2035 r. jest powszechnie rozumiany jako zasadniczo niezgodny ze stosowaniem ICE dla nowych pojazdów drogowych (samochody osobowe + dostawcze), tj. ogólny zakaz ICE dla takich pojazdów, w tym hybryd wszystkich typów, jest proponowany w dokumencie

Sources: EU press releases, draft EU legislation (2021)

Overall timeline of worldwide CO_2 requirements up to 2035



Expected Updates:

EU Green Deal 2030 (additional 10% reduction) = 43-48 g/km

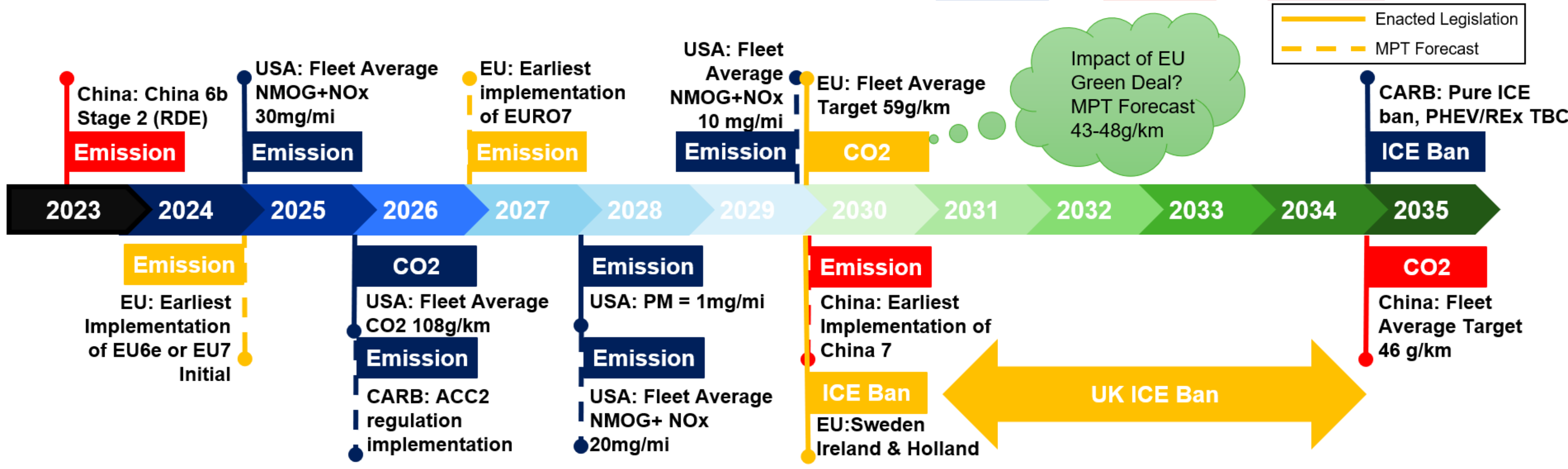
USA NDC (04/2020 52% reduction from 2005 levels) = ~92g/km

Source: S. Williams, Mahle Powertrain (2021)

MAHLE Powertrain

Overall timeline of worldwide CO_2/emissions requirements up to 2035

Future Emissions Legislation
MAHLE Powertrain View



MAHLE Powertrain

Source: S. Williams, Mahle Powertrain (2021)

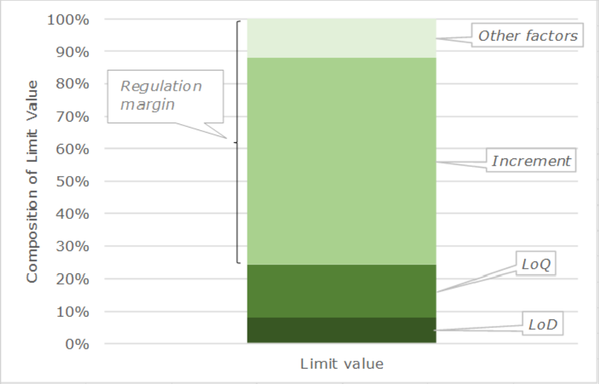
Expected LD Euro 7 emissions standard (1/3)

- Various analyses and scenarios have been presented since mid-2018 – considerable speculation within the industry; public interest also much higher than previously (linked to topic of ICE bans/electrification)
- CLOVE proposals (both scenarios) show limit values generally lower than previous predictions
- China 6b is more stringent than Euro 6d; in the end, Euro 7 may be *roughly* equivalent to China 6b (see Ball et al., https://doi.org/10.4271/2020-01-0654)

Source: CLOVE (2020-21)

Pollutant	CO	NMOG	NO_x	PM	PN_{10}	NH_3	CH_4(*)	N_2O(*)	HCHO
Unit	mg/km	mg/km	mg/km	mg/km	#/km	mg/km	mg/km	mg/km	mg/km
Scenario 1									
Cars with and Vans	400	45	30	2	1×10^{11}	10	**20**	**20**	5
Vans with TPMLM>2500 kg & PWR<35 kW/t	600	45	45	2	1×10^{11}	10	**20**	**30**	**10**
Scenario 2									
Cars and Vans	400	25	20	2	1×10^{11}	10	10	10	5
	600	25	30	2	1×10^{11}	10	10	**15**	**10**

- Limit setting factors



- Analyser dependent variability increment is 3-4 x LOQ (equivalent to 10 x LOD). This includes analyser-specific issues and reproducibility

Expected LD Euro 7 emissions standard (2/3)

As many as 5 new measurement items (species) to be added. NH_3, CH_4 are familiar; NMOG, HCHO and N_2O follow US precedent, but EU may eventually require **all** regulated species to also be measured **on-road**

Source: CLOVE presentations to AGVES meetings (2020-21)

Proposed species to be included in Euro 7

Species	Groups	PEMS available Traditional/New	Technologies in-laboratory /on-board
Nitrogen Oxides, NO_x	AQ (1,2,3,4,5,8)	Yes/Yes	Dual CLD, NDUV, QCL, FTIR / on-board PEMS could be by QCL or FTIR.
Carbon Monoxide, CO	AQ (1)	Yes/Yes	NDIR, FTIR /PEMS currently poor. Improvement needed by using e.g. FTIR.
Solid particles, SPN	AQ (1)	- /Yes	PN23 available. PN10 at the market-ready stage. PMP work.
Particulate matter, PM	AQ (1,7,8)	Yes (not for cars)	PM-PEMS used for HDVs is not practical for cars.
New species			
Ammonia, NH_3	AQ (1,3,4,8)	- /Yes	LDS, QCL, FTIR / on-board PEMS could be by QCL or FTIR.
Nitrous Oxide, N_2O	GHG & AQ (1, 6)	Yes/Yes	GC-ECD, QCL, NDIR, FTIR / on-board could be FTIR or QLC.
Methane, CH_4	GHG & AQ (1, 5)	Yes (not for cars)/Yes	FID with cutter, GC-FID, FTIR / on-board could be FTIR.
Formaldehyde, HCHO	AQ (1,2,5)	- /Yes	DNPH&HPLC, PTR-MS, FTIR / on-board could be FTIR.
Non-Methane Organic Gases, NMOG	AQ (1,2,5,8)	- /Calculated	NMOG could be FID (THC) minus CH_4 plus HCHO. If other than FID (THC), oxygenates to be analysed by FTIR, GC.

(1) health (2) vegetation (3) acidification (4) eutrophication (5) tropospheric ozone (6) stratospheric ozone (7) GWP black carbon (8) sec. aerosols

Expected future HD EU emissions standards (1/2)

Proposals presented have been lower than expected – CARB-like philosophy of ultra-low emissions

Note also new (additional) pollutants NMOG, NH_3, N_2O

In the EU: general flow of emissions requirements and emissions control technologies from heavy duty to light duty

e.g.: WHTC→WLTP, ISC→RDE, HD-SCR→LD-SCR

Limit levels achievable for useful life of: N3 > 16t up to 0.7 Mio. Km, other HDVs 0.3 Mio. Km

100 Percentile Limit	NOx	SPN_{10}	PM	CO	NMOG	NH3	N2O*	CH4*
HD 2 (opt. +cc SCR diesel)	350	5.0E+11	12	3500	200	65	160	100
HD 3 (as HD2+pre-heat)	175	5.0E+11	12	1500	75	65	160	85
HL 2 (LNG as HD2)	350	5.0E+11	12	7500	150	50	225	500
HC 2 (opt. CNG SI)	350	5.0E+11	12	6500	150	70	300	450

90 Percentile Limit	NOx	SPN10	PM	CO	NMOG	NH3	N2O*	CH4*
HD 2 (opt. +cc SCR diesel)	90	1.0E+11	8	200	50	65	60	50
HD 3 (as HD2+pre-heat)	90	1.0E+11	8	200	50	65	60	50
HL 2 (LNG as HD2)	90	1.0E+11	8	300	50	50	60	350
HC 2 (opt. CNG SI)	90	1.0E+11	8	300	50	70	35	300

„Budget" ≤ 3 x WHTC work	NOx	SPN_{10}	PM	CO	NMOG	NH3	N2O*	CH4*
HD 2 (opt. +cc SCR diesel)	150	2.0E+11	10	1250	75	65	140	30
HD 3 (as HD2+pre-heat)	100	2.0E+11	10	600	50	65	140	30
HL 2 (LNG as HD2)	150	2.0E+11	10	2700	75	50	200	500
HC 2 (opt. CNG SI)	150	2.0E+11	10	2300	75	70	260	350

Sources: CLOVE (2021-21)

EVs are still subject to the laws of physics (and finance) – nothing for free!

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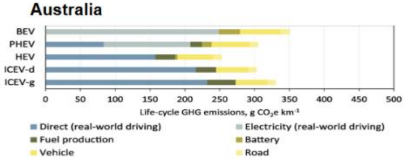
Zero emission hype

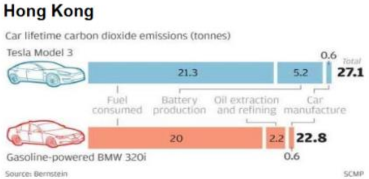
Zero emissions won't be possible until a "perpetuum mobile" is invented.

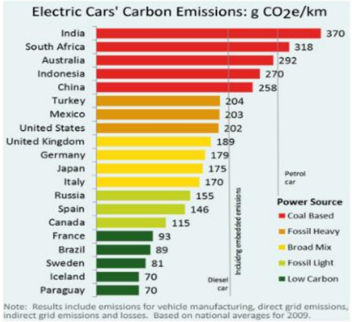
"Perpetual motion, the action of a device that, once set in motion, would continue in motion forever, with no additional energy required to maintain it. Such devices are **impossible** on grounds stated by the first and second laws of thermodynamics." *Source: Encyclopaedia Britannica*

Zero emission? Not quite.



Ref.: P. Wolfram, T. Wiedmann, Applied Energy 206 (2017) 531-540.



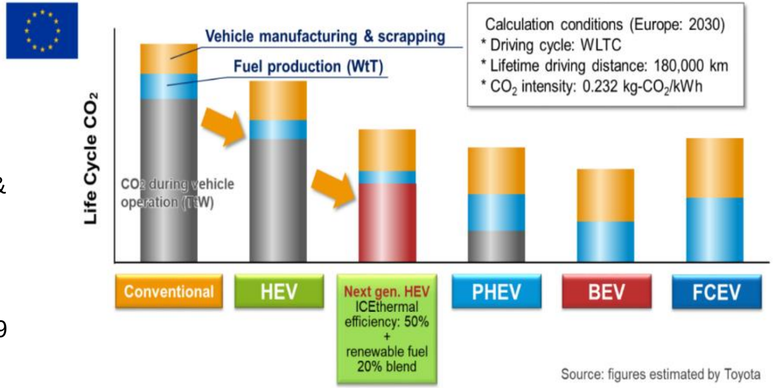


Source: Euan Mearns, Energy Matters, 2017

Not only CO_2: power generation creates PM/PN, SO_x, NO_x, CO, NH_3, PAH, etc (varies by fuel type)

	Household heating	Road transport	Energy	Industry	Agriculture	Other
PM_{10}	42%	11%	10%	17%	15%	5%
$PM_{2.5}$	57%	11%	12%	10%	4%	6%
NOx	14%	39%	31%	3%	5%	8%
SOx	13%		78%	7%		2%

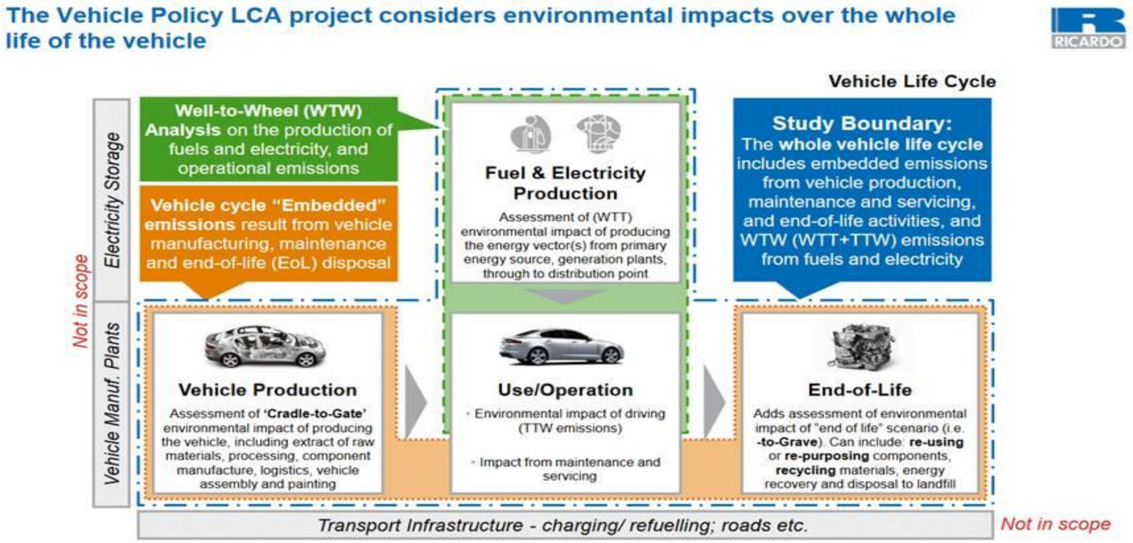
Sources: B. Zhmud, ACI Base Oils & Lubricants Summit, Florence, Italy, 2018;
K. Keiji, "Diversified electrification" Vienna Motor Sympoiusm 2019;
European Environment Agency 2019



Source: figures estimated by Toyota

The complete picture: using LCA to play fair

Worldwide emissions regulations are based on the historical tank-to-wheel (**TTW**) formula (from CARB), which is no longer fit for purpose. Well-to-wheel (**WTW**) (or even full lifecycle analysis, **LCA**, “from cradle to grave”) would be a genuinely fair way to compare and could achieve real reductions in GHG and various pollutants, greatly improving the long-term, holistic sustainability of road transport.



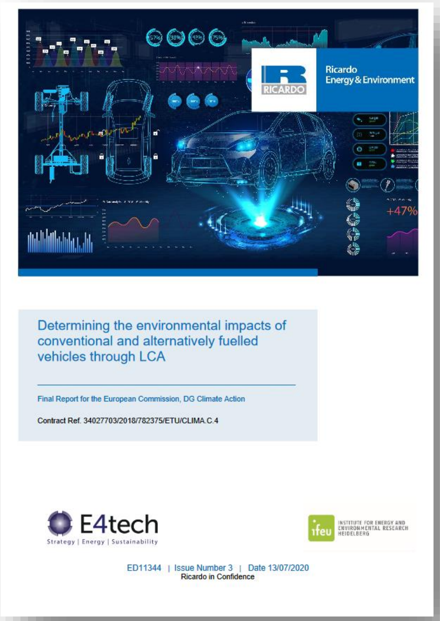


Image source: S. Amaral (Ricardo), Workshop on life cycle assessment methods to support India’s efforts to decarbonise transport, 13 April 2021

450-page Ricardo LCA report (June 2020) available online: ec.europa.eu/clima/

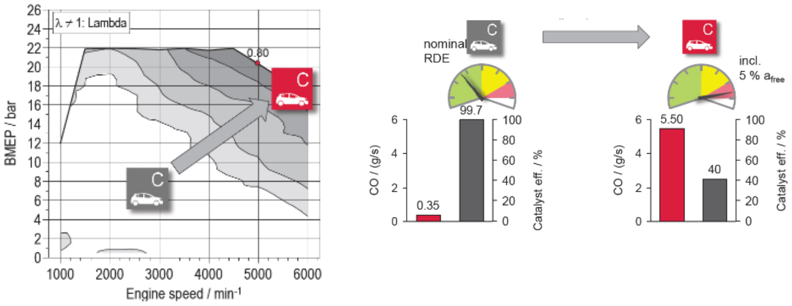
LONG-TERM DEVELOPMENT → for Euro 7/China 7/others and to meet long-term CO_2 requirements

- Further development of SI DI engines (lean burn?); majority direct injection
- Alternative fuels development (HVO, DME, Ethanol, Methanol, CNG/LNG)
- Reducing share of Diesel engines – new solution Diesel Hybrid
- HCCI/GCI engines
- CNG fuelled SI engines, GPF for all SI engines
    - GPF for PFI affects direct injection cost:benefit ratio
- Hybridization → MHEV, PHEV
- Electric powertrain → BEV
- E-fuels
- Hydrogen ICE
- Fuel cells and hybrid fuel cells

Not only electrification!

Engine/combustion - Spark Ignition

- “Map flattening” to λ1 to avoid enrichment, reduce fuel consumption and aid aftertreatment
- Increase in fuel injection pressure (to 500 bar – or more)
- Load partitioning powertrain electrification, intelligent energy management (route planned based on navigation system input)
- Management of knock/temperature via water injection
- Ongoing discussions on the subject to higher RON fuel and alternative fuels such as methanol

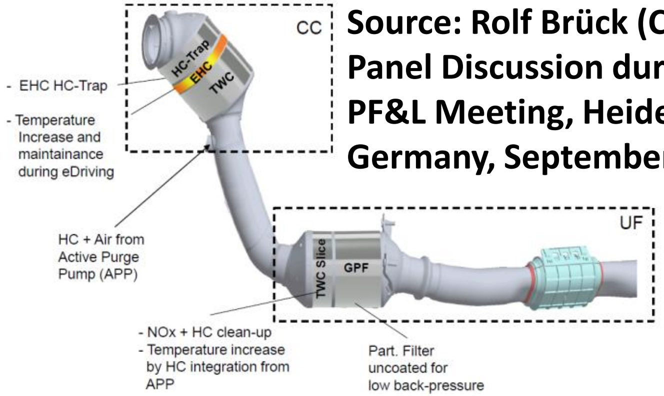


Source: Bamugarten et al. (FEV), 2018

Aftertreatment

- Three-way catalyst is now almost 50 years old, but continues to be optimised
- GPFs now well established for direct injection engines; full control of PN at 10 nm will require further optimisation (often 2 filters), expansion to other engine/fuel types
- Introduction of legislative limits for additional pollutants would require significant optimisation work, since standalone solutions are not currently known

Roadmap Gasoline „EU 7“ / RDE / SULEV 20

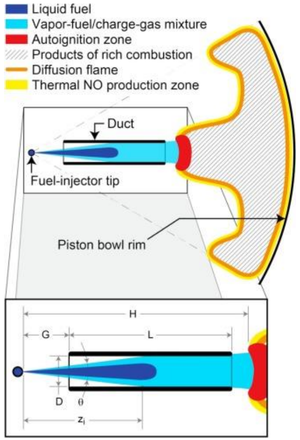


Source: Rolf Brück (Continental), Panel Discussion during SAE PF&L Meeting, Heidelberg, Germany, September 2018

Engine/combustion – Compression Ignition

Ducted fuel injection – idea has regained attention (e.g. Mueller et al., 2017; Millo et al., 2021)

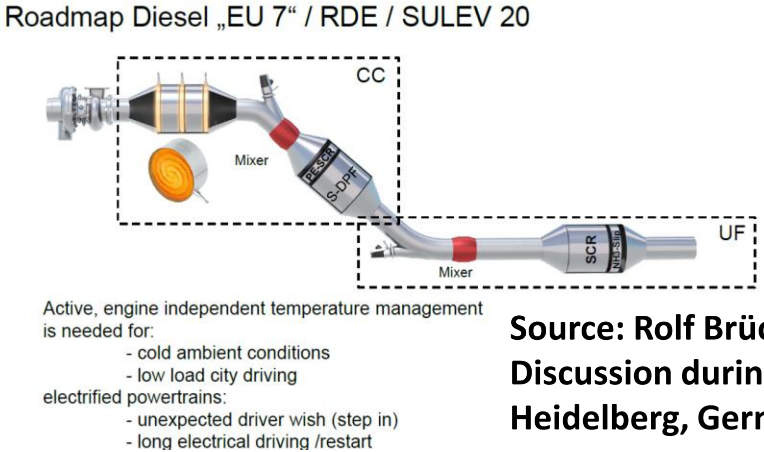
Ongoing improvements to turbochargers; turbo electrification



Mueller et al., 2017

Aftertreatment

Various proposals have been put forward for aftertreatment capable of achieving low real-world NOx, even for boundary conditions exceeding current RDE requirements. Some form of external energy input is likely to be required: electrically heated catalyst or burner, although some systems are only passively heated. US/China N_2O limits may be implemented in EU – optimisation required



Source: Rolf Brück (Continental), Panel Discussion during SAE PF&L Meeting, Heidelberg, Germany, September 2018

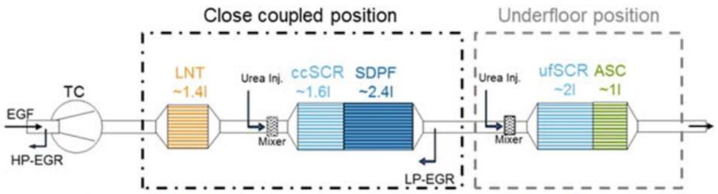
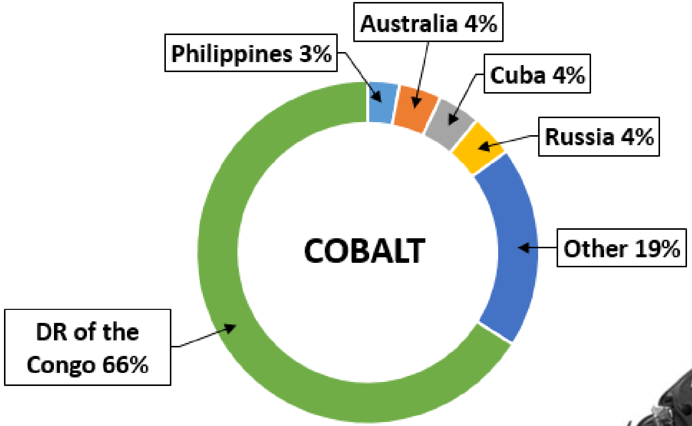
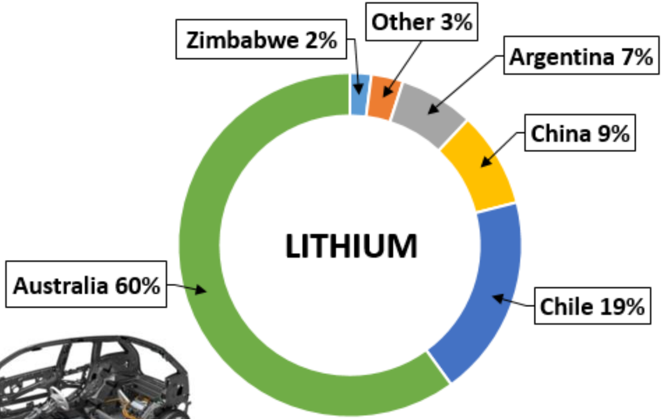
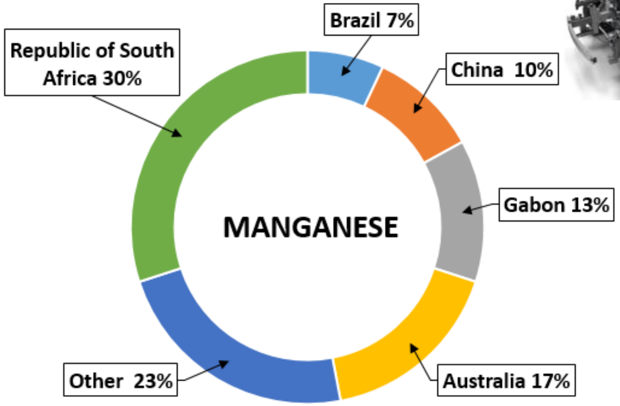


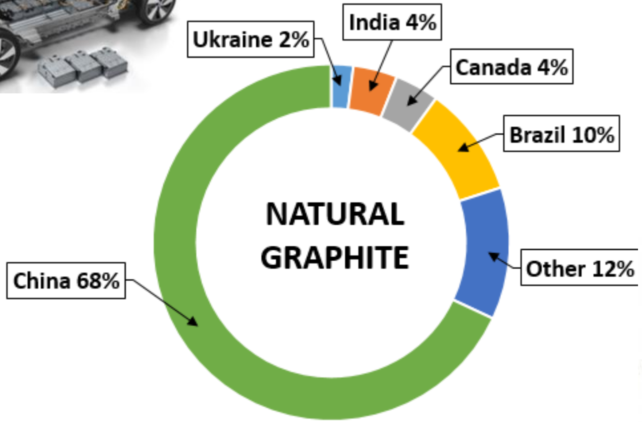
Figure 3: Exhaust aftertreatment system layout

Source: AECC, Vienna Motor Symposium, 2019









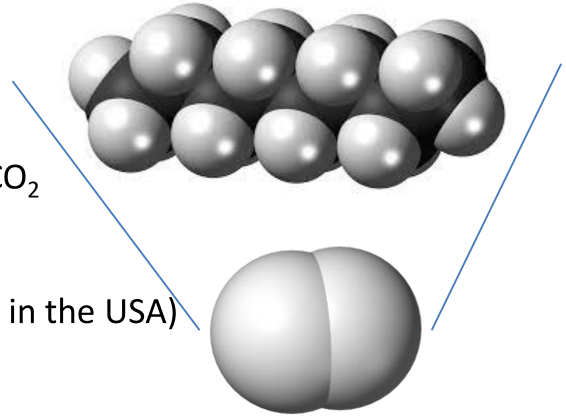
Very rapid development in alternative means of transport (especially urban): electric bicycles, scooters, electric tricycles (especially in China), **all equipped with batteries**.

This causes intense competition for key raw materials – see graphs.

Hydrogen: lightening the load?

BOSMAL

The concept has a long history and has been abandoned several times in the past. Has the time finally come for H_2 in road transport? CO_2 legislation and concern over electrical powertrains' weak points is driving very strong interest in H_2



Usage in ICE – stepping stone from current technology:

- dual fuel (potentially including retrofit)
- bi-fuel (potentially including retrofit) – to overcome range concerns
- monofuel (dedicated engine designs to make use of very high RON) – zero CO_2

Usage in H_2 fuel cells:

no combustion, no NO_x; FCEVs already on the market (Toyota; Hyundai + Honda in the USA)
Seen as a key route for the HD sector to reduce (even eliminate) CO_2 emissions

Problems of production and storage:

Water is stable and so electrolysis is energy-intensive – ongoing research into catalysts and maximising use of renewable electricity
Locations with high solar flux and access to water could become H_2 hotspots
Storage and transport of gaseous fuels (also when liquified) is challenging – very low overall efficiency for small quantities
Highly uneven, mostly underdeveloped infrastructure: USA and China both have <100 H_2 refuelling points…but Japan has >130
General and sector-specific safety concerns remain – not clear to what extent the public accept H2 as safe

Fuel cell electric vehicles (FCEVs)

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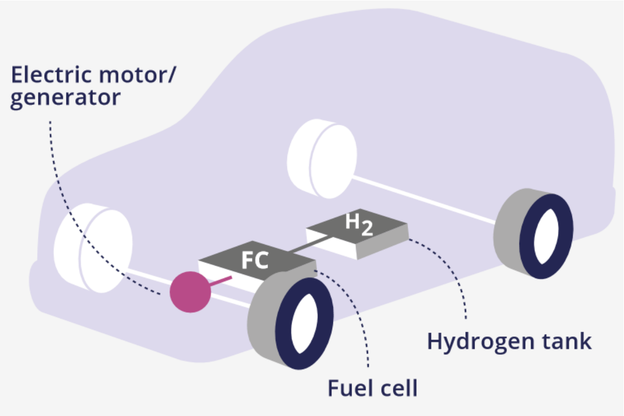
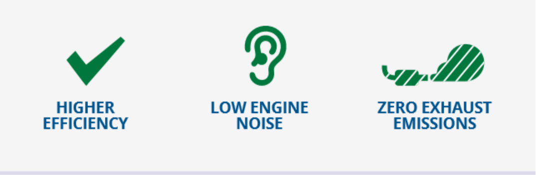
FCEVs are entirely propelled by electricity. In this case, the electrical energy is not stored in a large battery system, but is instead provided by a fuel cell 'stack' that uses hydrogen from an on-board tank combined with oxygen from the air. The main advantages of FCEVs over BEVs are their longer driving ranges and faster refuelling. Because of the current size and weight of fuel cell stacks, FCEVs are better suited for medium-sized to large HD vehicles and buses and longer distances.



ADVANTAGES



Source: Electric vehicles in Europe; EEA Report | No 20/2016

DISADVANTAGES

Fuel cell electric vehicles use a fuel cell to create on-board electricity, generally using compressed hydrogen and oxygen from the air.

Further technological development is needed for FCEVs to improve their durability, lower the costs and establish a hydrogen fuelling infrastructure, including standalone stations or pumps for hydrogen.

Indicative electric driving range: 160-500 km (increases with effective energy recuperation)

Hybrid Fuel Cell Powertrain

- Electric vehicles combined with batteries and equipped with fuel cell technology – an **innovative** and **favorable** solution
- Concept offers zero emission from tank-to-wheel
- So far, the automotive industry has **focused mostly on pure battery versus pure fuel cell approaches**
- This powertrain concept is a combination of battery and fuel cell technologies in a single dedicated hybridized powertrain architecture, benefitting from all possible synergies available
- **High range can be achieved (>> 600km)**
- Effective hydrogen storage still a **challenge**

- This approach toward a hybridized fuel cell vehicle **overcomes** the current barriers of electromobility as the driveability performance, but **there is still much to do in term of optimization**
- **Heavy duty sector could act as an incubator for fuel cell technology, later passing to light duty**

Source: Hybrid Fuel cell Powertrain. Electric & Hybrid Technology International. January 2018.

e-fuels: the promised fuel, delivered via green electrons

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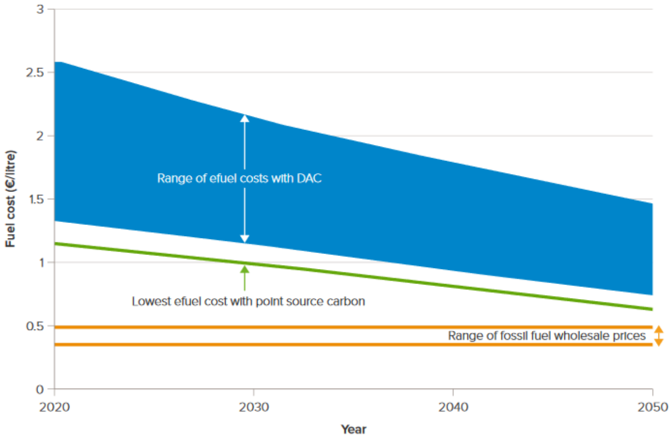
E-fuels are synthetic fuels created using hydrogen produced using sustainable electricity
Carbon input options are CO_2 obtained from biogenic/industrial processes, or even capture of CO_2 from the atmosphere

Why?
E-fuels: pathway to use renewable electricity, avoid heavy batteries and improve the sustainability of the current fleet – can be burned in a wide range of ICE
CO_2 capture from the atmosphere closes the circle

Technology readiness levels (TRLs) of the various sub-processes are higher than often assumed
Difficulties with scale-up and attracting funding; traditional business models not always suitable or relevant
High costs have proven problematic so far, but this situation will most likely change
Incremental improvements in cost efficiency via catalysis, photovoltaics, energy management, etc all play a part



In addition to large life-cycle CO_2 benefits and making use of existing fleet, modifications to fuel properties can potentially result in lower pollutant emissions = win-win-win situation

Image source: UK Royal Society Briefing DES6164 (2019); other sources: CONCAWE Report no. 14/19 (2019), Hanggi et al. A review of synthetic fuels for passenger vehicles (2019)

Alternative liquid fuels: TTW≠WTW, WTW≠vehicle LCA

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Tank to wheel (TTW) is a very small part (and a poor representation) of the full well to wheel (WTW) picture
However, WTW is not full LCA – it still excludes the impacts of powertrain manufacturing/disposal
Usage of alternative liquid fuels in the existing fleet is highly attractive from the full LCA point of view (embodied energy)

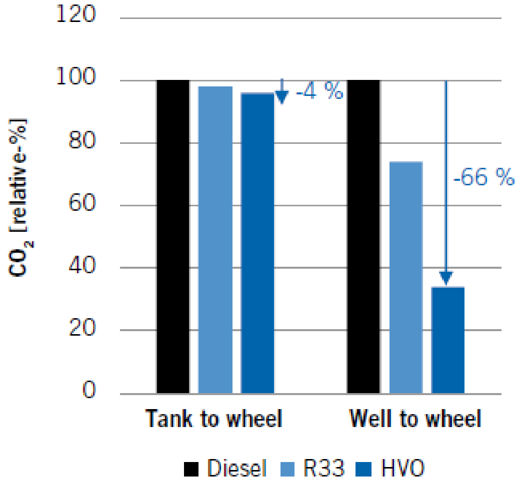

FIGURE 8 CO_2 emission for diesel and HVO in tank-to-wheel versus well-to-wheel consideration (© IAV)

- B30: -14 to -26%
- HVO: -60 to -82%
- BTL: -64% to -200%
- E-fuel: -93%

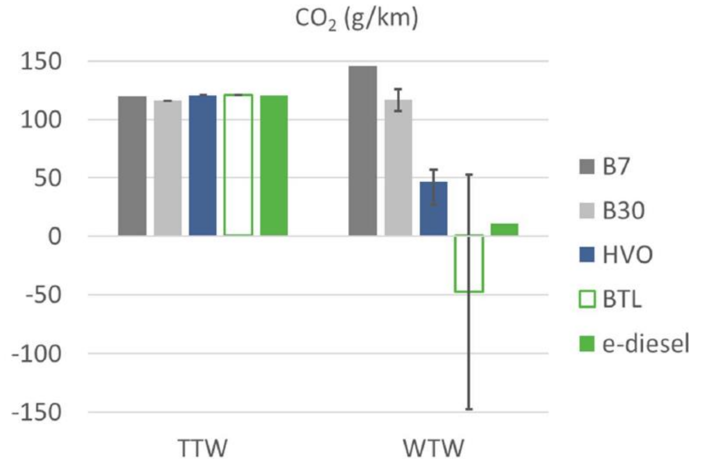

Image sources:
Demuynck et al., Improving Air Quality and Climate Through Modern Diesel Vehicles, MTZ Worldwide 81, 52-59 (2020)
Demuynck, J. Advanced emission controls and renewable fuels for low pollutants and lifecycle CO_2 emissions, AGVES presentation (2021)

Full LCA comparison: various powertrains vs typical 2020 ICE

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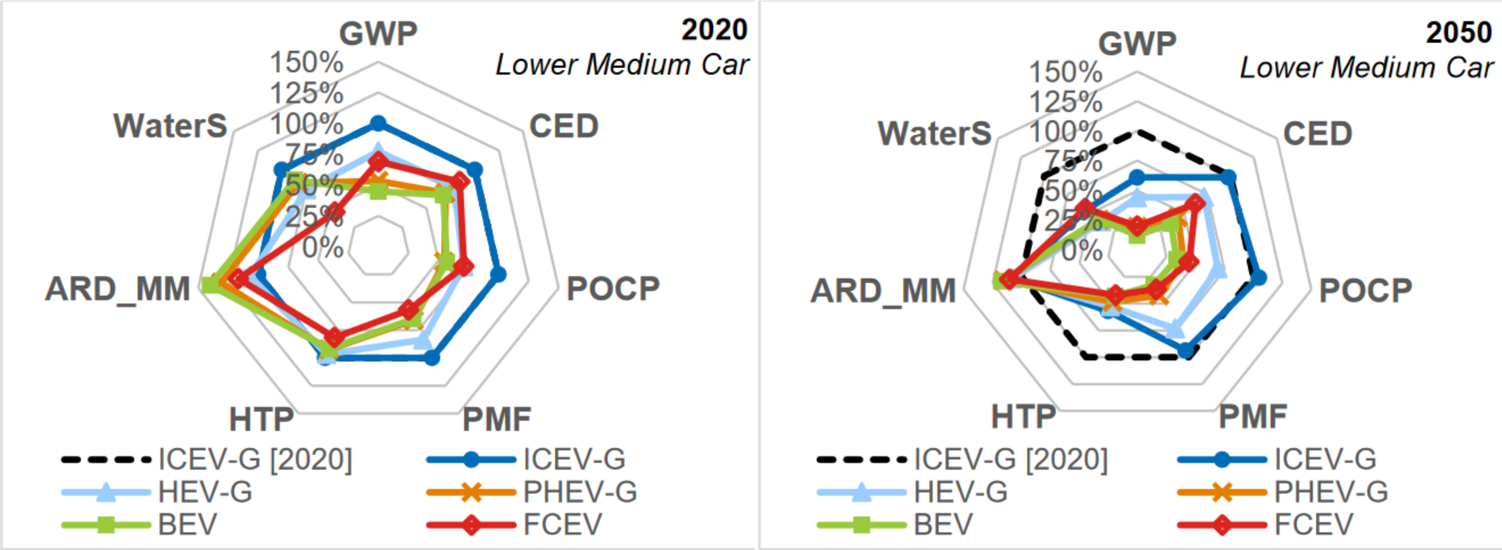
Figure ES4: Summary of the relative impacts for Lower Medium Cars for the most significant mid-point impacts for road transport, by powertrain for 2020 and 2050 (Tech1.5 Scenario)



Notes: Total emissions are presented relative to a 2020 conventional gasoline ICEV = 100%.
Powertrain types: G- = Gasoline; ICEV = conventional Internal Combustion Engine Vehicle; HEV = Hybrid Electric Vehicle; PHEV = Plug-in Hybrid Electric Vehicle; BEV = Battery Electric Vehicle; FCEV = Fuel Cell Electric Vehicle.
LCA impacts: GWP = Global Warming Potential, CED = Cumulative Energy Demand, POCP = Photochemical Ozone Creation Potential, PMF = Particulate Matter Formation, HTP = Human Toxicity Potential, ARD_MM = Abiotic Resource Depletion, minerals and metals, WaterS = Water Scarcity.

Source: https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/2020_study_main_report_en.pdf

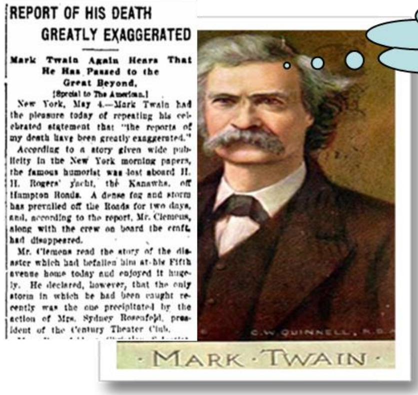
Tank to wheel→well to wheel→life cycle

Only CO_2→ GHG+electricity→ 7 impact categories over full life cycle

Wnioski

- Obowiązujące i planowane normy dotyczące emisji CO_2 wymuszają hybrydyzację, elektryfikację i stosowanie paliw niskoemisyjnych lub nie węglowych dla LD i HD (wodór, być może skroplony; być może nawet amoniak)
- Wszystkie nowe pojazdy na rynku z silnikiem spalinowym (dowolnego rozmiaru/typu) będą podlegać złożonym , rygorystycznym wymogom dotyczącym emisji, z których większość będzie neutralna pod względem zużycia paliwa i stosowana poza laboratorium w testach RDE
- W UE i Chinach etapy Euro 7/VII i Chiny 7/VII są bliskie ogłoszenia i sformalizowania, aby uwzględnić dodatkowe ograniczenia (np. PN10, emisje w niskich temperaturach, dodatkowe zanieczyszczenia gazowe, udoskonalenia metody RDE/ISC). Jeszcze większy nacisk będzie położony na zgodność z rzeczywistymi emisjami przez cały okres użytkowania — wyzwanie dotyczące trwałości – 15 lat i/lub 250 tys. km
- Pomimo ogromnej presji na elektryfikację układów napędowych, bardzo trudno będzie zrezygnować z ICE dla transportu drogowego – pozostanie ważny udział ICE w rynku (głównie w różnych konfiguracjach hybrydowych i pojazdach HD). Silniki IC stosowane w hybrydowych układach napędowych o znacznym zasięgu elektrycznym mogą mocno różnić się od tych obecnie stosowanych
- E-paliwa (oparte na węglu, ale syntetyczne) mogą być dobrym kompromisem między zelektryfikowanymi układami napędowymi, a ICE
- Światowe przepisy dotyczące emisji oparte są na historycznej formule **TTW** (z CARB), która nie jest odpowiednia do tego celu. **WTW** (lub CtG –”od kołyski do grobu”) byłaby naprawdę uczciwym sposobem porównywania typów napędów i mogłaby osiągnąć rzeczywistą redukcję emisji gazów cieplarnianych i poprawić zrównoważony rozwój transportu drogowego

ICE case...


REPORT OF HIS DEATH GREATLY EXAGGERATED

Mark Twain Again Hears That He Has Passed to the Great Beyond.

[Special to The American.]

New York, May 4.—Mark Twain had the pleasure today of repeating his celebrated statement that "the reports of my death have been greatly exaggerated."

According to a story given wide publicity in the New York morning papers, the famous humorist was lost aboard H. H. Rogers' yacht, the Kanawha, off Hampton Roads. A dense fog and storm has prevailed off the Roads for two days, and, according to the report, Mr. Clemens, along with the crew on board the craft, had disappeared.

Mr. Clemens read the story of the disaster which had befallen him at his Fifth avenue home today and enjoyed it hugely. He declared, however, that the only storm in which he had been caught recently was the one precipitated by the action of Mrs. Sydney Rosenfeld, president of the Century Theater Club.

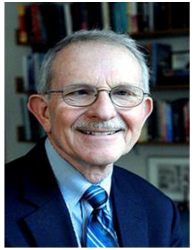
"the reports of my death are greatly exaggerated"

"the reports of ICE engines' death are greatly exaggerated"

the rumour disruptors….

Professor John B. Heywood:

"there is still some life left in combustion engines…"



Prof. Heywood predicts that in 2050, 60% of light-duty vehicles will still have combustion engines, often working with electric motors in hybrid systems and largely equipped with a turbocharger. Vehicles powered purely by batteries, he estimates, will make up 15% of sales (**PANEL DISCUSSION during 2018 SAE World Congress**)

2018 **expert opinion: "Up to to about 80% of passenger cars will be equipped with Combustion Engines as individual powertrain source or in hybrid system to 2030" SAE 2018 International Powertrains, Fuels & Lubricants Meeting, 17-19 September 2018, Heidelberg, Germany, Expert Panel Discussion: 'The Future of Combustion Engines' – participants' overall conclusion**

2019 **expert opinion: "The final propulsion solution for passenger cars will be a hybrid which can deliver the advantages of both EVs and ICEs" SAE 2019 WCX, 9-11 April 2019, Detroit, USA, Expert Panel Discussion: 'EU/China Emissions Regulations' – participants' overall conclusion**

2020 **expert opinion from various conferences: "ICEs will remain in use in road transport for decades, perhaps as hybrids and perhaps fuelled with e-fuels and hydrogen (in some cases)"**

2021 **expert opinion: "Anyone who really wants to set nitrogen oxide emissions to zero would have to ban the electric fleet immediately"**

In defence of ICEs – academics from across Europe speak out

"Anyone who really wants to set nitrogen oxide emissions to zero would have to ban the electric fleet immediately"

Prof. Thomas Koch (Karlsruhe Institute of Technology)

IASTEC
international association of sustainable drivetrain and vehicle technology research

This summer, IASTEC released a position paper and an open letter strongly critiquing the current "electric-only" approach and calling for a more objective assessment of the environmental performance of road vehicles

Sources: iastec.org (2021); automotive-opinion.com (2021)

Dziękuję za uwagę – proszę o pytania

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