

### Market Update

- Volkswagen is showing readiness for significant tightening of CO<sub>2</sub> standards to be announced on July 16<sup>th</sup>. In Europe, it announced plans for battery electric vehicles to account for 70% of sales by 2030 and 100% by 2035. In markets such as the US and China which are lagging in terms of CO<sub>2</sub> standards or electrification targets (China targets only 50% EV sales by 2035), VW has not made a commitment to the timing for full electrification.

<https://www.reuters.com/business/sustainable-business/vw-end-sales-combustion-engines-europe-by-2035-2021-06-26/>

A similar message was given by its subsidiary, Audi: no new ICE models to be introduced beyond 2026, a complete shift to EV sales by 2033 in Europe, but continued ICE sales in China beyond 2033.

<https://www.audi-mediacycenter.com/en/press-releases/audi-ceo-duesmann-at-berlin-climate-conferenceaccelerated-transition-to-e-mobility-14069>

- The European Environment Agency (EEA) published its provisional CO<sub>2</sub> emissions from light-duty passenger cars for 2020. The fleet averaged emissions were 107.8 g/km, which are 14.5 g or 12% lower compared to 2019. This is mostly driven by an increase in electric vehicle sales, which increased from 3.5% share in 2019 to 11% in 2020. Adjusting for EV sales, it is seen that there has been very little to no improvement in fuel economy of the ICE powered vehicles.

<https://www.eea.europa.eu/highlights/sharp-decrease-in-emissions-of>

### Regulatory Update

- Europe has approved the Climate Law, which will target a 55% reduction in greenhouse gas emissions by 2030, compared to 1990 levels, and reach net zero by 2050. The previous target was 40% reduction, so new measures will be announced to meet the more ambitious target. These will be announced on July 14<sup>th</sup>, where it is expected that CO<sub>2</sub> limits for the transportation sector will be further tightened.

- The US EPA has announced that it will reconsider the previous decision to retain the national ambient air quality standards (NAAQS) for fine particles or PM<sub>2.5</sub>. A large body of scientific literature suggests that the current standard of 12 ug/m<sup>3</sup> provides insufficient protection from the health effects of fine particles and that disadvantaged communities are especially at risk. The revised assessment will lead to a proposed rulemaking by summer 2022 and a final rule in spring 2023.

<https://www.epa.gov/newsreleases/epa-reexamine-health-standards-harmful-soot-previous-administration-left-unchanged>

- Tier 5 standard for off-road engines: California's Air Resource Board has started exploring the next regulations to limit NO<sub>x</sub> and particulates from the off-road sector, using learnings from the Low NO<sub>x</sub> Omnibus rulemaking for on-highway heavy-duty vehicles. A CARB-funded study done at Southwest Research Institute (SWRI) shows that significant emission reductions could be achieved. Tailpipe emissions from two engines were measured: one a 6.8L engine using

DOC + DPF + SCR and another a 4.5L engine using DOC + SCR only. A new “low load application cycle (LLAC)” was constructed, which showed the challenges of meeting the Tier 4 NOx limit due to catalyst temperature dropping below light-off. Modeling shows the potential for significant improvements via engine calibration and advanced SCR catalysts. As expected, particle emissions were 2 – 3 orders of magnitude lower for the engine using DPF.

<https://dieselnet.com/news/2021/06carb.php>

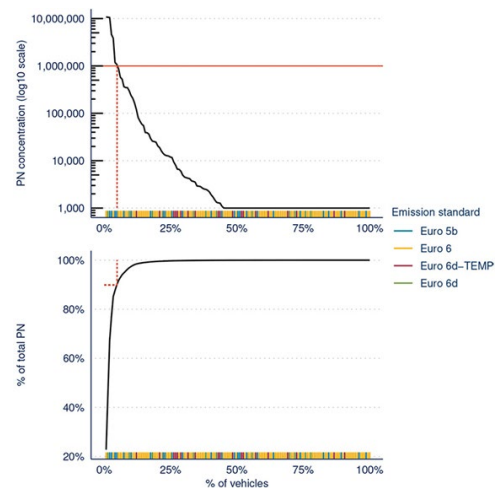
- The Joint Research Center at the European Commission and the Chinese Vehicle Emission Control Center held a meeting to discuss the approach for Euro 7 and China 7. VECC showed that implementation of China 6/VI has led to significant improvements compared to the previous level, as verified by remote sensing. Some areas for improvement have been identified, for example greatly increased pollution at altitudes > 2,400 m (limit in China 6b), cold-starts and hybrid operation for heavy-duty vehicles.

Presentations are available here:

<https://ec.europa.eu/jrc/en/science-update/sino-eu-workshop-presentations>

- The New Periodic Technical Inspection (NPTI) has been adopted by Belgium, Netherlands and Germany starting 2022, and this will include PN measurements to detect malfunctioning or tampered DPFs. In a recent study of over 250,000 vehicles in Brussels using this method, it was found that only 5% of Euro 5b and Euro 6 vehicles had compromised DPFs but these accounted for over 90% of the cumulative fleet emissions. This highlights the need to ensure that all vehicles are clean and equipped with good filters.

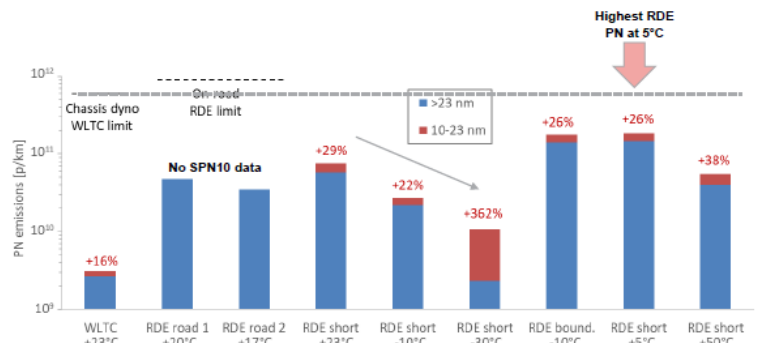
<https://www.trueinitiative.org/blog/2021/may/true-brussels-emissions-testing-dpf-malfunctions-and-tampering-responsible-for-90-of-all-diesel-euro-5b-and-6-emissions>



- India will require 20% ethanol blending in gasoline starting April 1, 2023. Currently, gasoline in India has ~ 8.5% ethanol. Note that the date for the 20% blending coincides with the introduction of the second phase of BS6 regulations, and ethanol content has implications for reduced particulate emissions, partly through displacement of aromatics content.

## Technology Update

- At the 24<sup>th</sup> ETH Conference on Combustion Generated Nanoparticles, Ricardo presented findings on particle emissions from a Euro 6d vehicle equipped with a GPF, under a wide range of testing and boundary conditions. With the GPF, the vehicle was found to emit well below the current RDE particle number limit ( $9 \times 10^{11}$  #/km), even at sub-zero temperatures and start-stop urban driving. The fraction of the sub-23 nm particles, down to 10 nm, was 14 – 60% depending on the test conditions. Interestingly, the PN showed a maximum at 5 °C and decreased at



both lower and higher temperatures, and this is likely due to the preconditioning of the filter in previous steps leading to either accumulation of passive regeneration of the soot layer.

<https://nanoparticles21.scg.ch/program1/program-overview>

- Cummins has published fundamental work exploring the pathway for N<sub>2</sub>O formation at low temperatures during standard SCR on Cu-SSZ-13 catalysts. The research shows that nitrate formation is likely not a pathway as was previously thought and that N<sub>2</sub>O proceeds through the formation of a Cu-oxy species, which in turn is formed during oxidizing pre-treatment of the catalyst. N<sub>2</sub>O is a new species that will be regulated in Euro 7 and can be particularly difficult to control.

<https://mobilitynotes.com/a-new-pathway-for-low-temperature-n2o-formation-on-scr-catalysts/>

Link to the article: <https://www.sciencedirect.com/science/article/pii/S0926337321003714?via%3Dihub>

- The DOE funded SuperTruck 2 program, which had as objectives a 55% brake thermal efficiency (BTE) engine and a doubling of the fleet efficiency, is nearing completion. Cummins reported having met the 55% goal, of which 4.4% increase was obtained using waste heat recovery (WHR). Daimler also reported having achieved 55% BTE, but without WHR. Navistar and Volvo also showed some work on evaluating advanced catalysts for lower NO<sub>x</sub> emissions. These results were presented at the DOE Vehicle Technologies Office Annual Merit Review, which covers the latest progress made on DOE funded projects on a broad range of topics related to mobility and transportation. All presentations are available at this link for download : <https://www.energy.gov/eere/vehicles/2021-vehicle-technologies-office-amr-presentations-program>

## Electrification / Non-conventional fuels / Other

- Electric vehicle sales projections

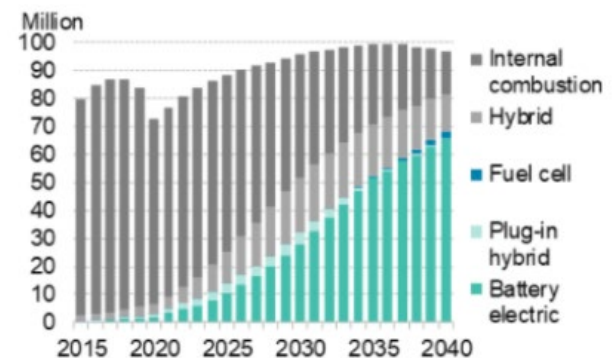
In its 2021 EV Outlook, Bloomberg predicts the following:

- 900 million ICE vehicles will be on the road in 2040.
- EV sales to grow from 3.1 M in 2020 to 14 M in 2025.
- EV sales to reach ~ 75-80% share by 2040 in advanced markets such as Europe, China and US but proceed slower in other parts of the world (50% in India, for example).
- Hybrid sales will also increase to ~ 20 million by 2030, before decreasing to ~ 10 million by 2040.
- Electrification of heavy-duty / commercial vehicles will lag and reach ~ 20% by 2040.
- Fuels: Oil demand decreases 22% from ~ 45 million barrels per day (Mbpd) to ~ 35 Mbpd in 2040. Electricity demand increases by 61% by 2040 to ~4,500 TWh.
- Battery prices could fall to \$58/kWh by 2030. Increased Mn content in batteries will reduce the demand for Ni. There are sufficient minerals to meet the battery demand, but increasing the pace of electrification than shown above will strain the materials availability and require smaller battery packs and recycling of minerals.
- CO<sub>2</sub> emissions from transportation are still going to increase by ~ 7% till ~ 2030, after which they return to 2019 levels by 2040 and reduce by 28% by 2050.

<https://about.bnef.com/electric-vehicle-outlook/>

Ernst & Young have also provided an updated view on the EV market, projecting that EV sales will dominate other powertrains in Europe by 2028, in China by 2033 and in the US by 2036. ICE sales are projected to fall to near zero levels by 2045.

Global passenger vehicle sales outlook by drivetrain - Economic Transition Scenario



Source: BNEF.

[https://www.ey.com/en\\_gl/news/2021/06/electric-vehicles-to-dominate-sales-five-years-sooner-than-expected-ey-analysis](https://www.ey.com/en_gl/news/2021/06/electric-vehicles-to-dominate-sales-five-years-sooner-than-expected-ey-analysis)

- The International Council on Clean Transportation (ICCT) has published a report which outlines the key elements of China's New Energy Vehicle (NEV) goals out to 2035. By 2025, the plan calls for 20% of annual sales to be NEVs and for electricity consumption of battery electric vehicles at 12 kWh/100 km, which is roughly 25% lower than the leading EVs today. 100% of the public fleets will be electric by 2035. There is also a shift in incentives from direct subsidies to taxation exemptions, charging subsidies and parking incentives.  
<https://theicct.org/publications/china-new-vehicle-industrial-dev-plan-jun2021>
- Tesla is expected to be the first OEM to start using NCMA (nickel, cobalt, manganese, aluminum) batteries, which use a high (90%) nickel content in the cathode and thereby cuts down on the use of cobalt. The batteries, produced by LG Energy Solution, will be used on Tesla Model Y vehicles.  
<https://electrek.co/2021/06/02/tesla-first-lg-new-ncma-nickel-based-battery-cells/>
- On the heels of the announcement of the all-electric F-150 Lightning, Ford has now introduced the first full hybrid pickup truck in the US. The Ford Maverick offers an EPA fuel economy of 37 mpg, power output of 191 hp, and 1,500 lb. standard towing capacity, increasing up to 4,000 lb. with other variants. The powertrain combines a 2.5L Atkinson 4-cylinder engine with full hybrid system powered by a 1.1-kWh Li-ion battery pack and a two-motor, power-split variable transaxle. The truck is priced very aggressively at a starting price near \$20,000.  
<https://www.sae.org/site/news/2021/06/ford-unibody-2022-maverick-aims-to-revitalize-the-compact-pickup>
- Hyundai's fleet of 46 XCIENT hydrogen fuel cell trucks in Switzerland have collectively exceeded 1 million kilometers of driving. The company plans to roll out 110,000 fuel cell trucks by 2025 and 500,000 by 2030, worldwide. The trucks are fueled by seven H2 tanks which can be refueled in 8 – 20 mins and provide a range of ~ 250 miles, and 72 kWh battery packs for supplemental power. The company also plans to expand into the tractor market in North America.  
<https://www.greencarcongress.com/2021/07/fleet-of-hyundai-xcient-fuel-cell-trucks-pass-1m-kilometer-mark-in-switzerland.html>
- Continuing from last month's coverage of renewable fuels: Oberon Fuels has started the world's first commercial production of renewable dimethyl ether (DME) in California. The fuel is seen as a replacement for diesel, a blend with propane or as a carrier for renewable hydrogen.  
<https://oberonfuels.com/2021/06/10/oberon-fuels-starts-commercial-production-of-renewable-dimethyl-ether-rdme-a-pivotal-step-towards-a-net-zero-future/>
- UK firm Storeega and Canadian company Carbon Engineering are working towards a large carbon capture and sequestration (CCS) project in Scotland. The plant is expected to be operational by 2026 and aims to remove one million tons of CO<sub>2</sub> from the air annually.  
<https://www.zmescience.com/science/scotland-is-building-a-massive-plant-capable-of-removing-one-billion-tons-of-co2-from-the-air-every-year/>

***Don't miss these upcoming events ...***

**15<sup>th</sup> International Conference on Engines & Vehicles, Capri, Napoli (Italy) Sept. 12-16, 2021**

<https://www.sae-na.it/>

SAE COMVEC, 2021, September 14-16, 2021, Rosemont, IL or online

[https://www.sae.org/attend/comvec?utm\\_source=google&utm\\_campaign=WCX21-0023](https://www.sae.org/attend/comvec?utm_source=google&utm_campaign=WCX21-0023)

FISITA 2021 World Congress, September 14-16, 2021, online

<https://go.fisita.com/fisita2021>

SAE Powertrains, Fuels & Lubricants Digital Summit, September 28-30, 2021, online

[https://www.sae.org/attend/pfl?utm\\_source=google&utm\\_campaign=WCX21-0023](https://www.sae.org/attend/pfl?utm_source=google&utm_campaign=WCX21-0023)

Symposium on International Automotive Technology (SIAT) 2021, Pune, India, 29<sup>th</sup> September – 1<sup>st</sup> October

<https://siat.araiindia.com/>

*See here for recent conference summaries and to mark your calendar for future conferences:*

<https://mobilitynotes.com/home/tech-updates/summaries-conferences-technical-papers/>