5-Min Monthly Read

October 2021

MOBILITY NOTES
On sustainable transportation

+ Upcoming events listed at the end

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Regulatory Update

- Since their last update 15 years ago, the World Health Organization (WHO) has revised the global air quality guidelines (AQGs) for particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. Based on new information available in these years, the AQGs are significantly lowered for PM and NO_2, while the "best practices" recommend monitoring of ultrafine particles down to 10 nm.
  https://apps.who.int/iris/handle/10665/345329

Pollutant	Averaging Time	2005 AQG	2021 AQG	Change (%)
$PM_{2.5}$, µg/m³	Annual	10	5	50% ↓
	24-hr*	25	15	40% ↓
PM_{10}, µg/m³	Annual	20	15	25% ↓
	24-hr*	50	45	10% ↓
O_3, µg/m³	Peak season**	-	60	New
	8-hr*	100	100	-
NO_2, µg/m³	Annual*	40	10	75% ↓
	24-hr*	-	25	New
SO_2, µg/m³	24-hr*	20	40	100% ↑
CO, mg/m³	24-hr*	-	4	New

- The US EPA has also issued a "Supplement to the 2019 Integrated Science Assessment for Particulate Matter", which will take another look at peer-reviewed studies published since the last PM NAAQS (national ambient air quality standards) and aim to revise the standard down from the current level or 12 µg/m³. Under the previous administration, the NAAQS for PM2.5 was kept unchanged despite mounting evidence of the health effects of particulates even at low concentrations.
  https://www.federalregister.gov/documents/2021/09/30/2021-20504/supplement-to-the-2019-integrated-science-assessment-for-particulate-matter-external-review-draft

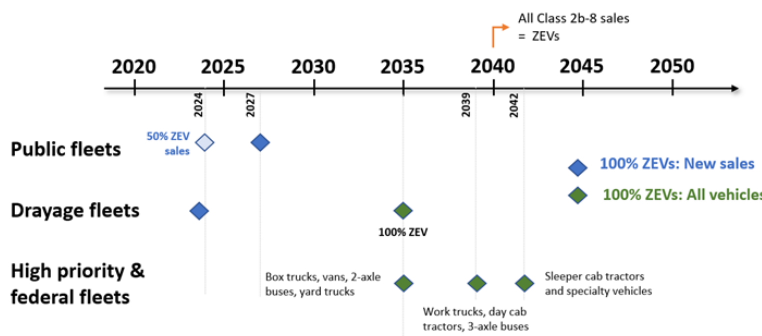
- The Joint Research Center (JRC) has published a report on the assessment of measurement uncertainty associated with portable emissions measurement systems (PEMS) used for real-world driving tests. The result is a recommendation to revise the uncertainty margin down from 0.32 to 0.23 for NOx and from 0.5 to 0.34 for particle number (PN) count. The conformity factor, expressed as "1+ uncertainly margin", are therefore recommended to be 1.23 for NOx and 1.34 for PN, and represent the factor by which lab limits must be multiplied to get to RDE limits.
  https://publications.jrc.ec.europa.eu/repository/handle/JRC124017

- China may replace the credit system for new energy vehicles with an emissions trading system, according to one source. This is not confirmed, but can have significant implications for the uptake for electrification.
  https://tinyurl.com/t7mp824t

Focus: CO_2 reductions from the trucking sector

- European regulations for heavy-duty vehicles currently require CO_2 emissions to reduce by 1% in 2025 and 30% in 2030 compared to a 2020 baseline for vehicles > 16 tons. (The standards are subject to a revision next year). Certification data for model year 2020 trucks has been recently published and provides the baseline. An ICCT report has analyzed this data. CO_2 emissions vary between 57 (long-haul) and 307 g/t-km (urban delivery). The penalties for missing the 2025 target is €4,250 per gCO2/t-km but OEMs who exceed the target each year can also accumulate credits towards future targets. The report also analyzes the technology adoption across major truck manufacturers. The most efficient diesel engine (a 15.3L MAN) reached 44.5% average thermal efficiency on the WHTC. Improved aerodynamics was identified as one of the key differentiators for the best performing trucks.
  https://theicct.org/publications/eu-hdv-co2-standards-baseline-data-sept21

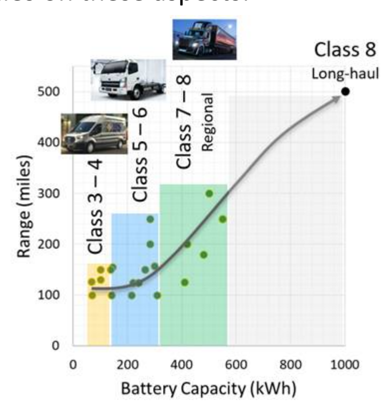
- California's Air Resources Board (CARB) held a workshop to discuss the latest thinking on the Advanced Clean Fleets proposed rulemaking. Per the latest proposal:



  - Trucks in California's public fleet will have to purchase 100% zero-emitting vehicles (ZEVs – electric and fuel-cell) by 2027.
  - Drayage fleets will have to be 100% ZEVs by 2035
  - Beyond 2040, all Class 2b – 8 vehicle sales will have to be ZEVs.

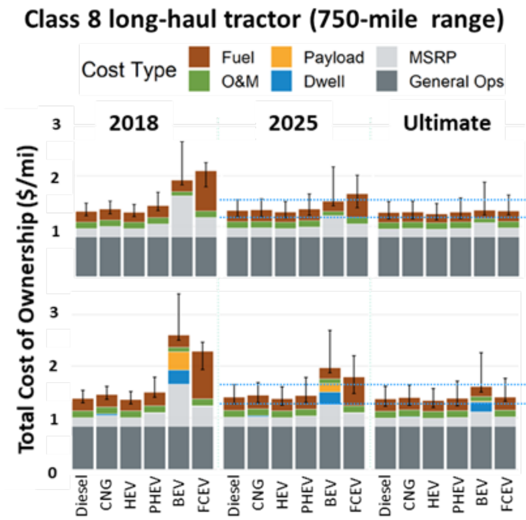
  CARB predictions of the vehicle population were discussed: the total vehicle will grow in the coming decades to meet increased transportation needs, but ZEVs are expected to enjoy the majority market share beyond 2040 – 45.
  https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets/advanced-clean-fleets-meetings-events

- In response to California's push for zero-emitting trucks, panelists at the recent SAE COMVEC conference raised concerns about the high upfront cost of electric trucks and lack of charging and H_2 refueling infrastructure, especially for long-haul trucks traveling over 500 miles per day. For these applications a 1 MWh battery would be needed, which in turn would require ultra-high-speed chargers and result in lost payload. A few studies on these aspects:
  - A summary of several representative and commercialized battery electric trucks is shown here. The black dot is a hypothetical case and not a real offering. It is seen that there is a gap currently for battery electrics that can address the long-haul (> 500 mile) trucking needs. A crude extrapolation based on the current battery sizes also shows that > 1 MW battery would be needed for such applications. However, this also shows that battery electrics can cover > 75% of the current trucking needs, which cover < 250 miles daily. Fuel cell trucks are expected to also fill that gap.
    https://mobilitynotes.com/will-batteries-be-the-limiting-factor-for-heavy-duty-electrification/



- A cost analysis done by NREL shows that by 2025, the total cost of ownership of battery electric and fuel cell trucks could be within the range of diesels considering uncertainty due to various factors (fuel cost, vehicle price, etc.). When considering "dwell times", i.e. the idle time lost for recharging the batteries and the cost of lost payloads, the cost of BEVs is higher compared to fuel cell trucks.
  Some key assumptions in the study include:
    - Battery pack price: $197/kWh today → $ 80/kWh in 2050
    - Battery pack weight: 4.7 kg/kWh today → 2.5 kg/kWh in 2050
    - H_2 price $10/kg today → $4/kg in 2050 | Fuel cell cost: $197/kW today → $60/kW in 2050
    - Diesel Class 8 efficiency: 47% today → 57% in 2050 | Engine cost: +$1,500 in 2025, - $6,000 in 2050

  https://www.nrel.gov/docs/fy21osti/71796.pdf



- The ICCT published a report on the infrastructure requirements for supporting a 100% zero tailpipe emitting heavy-duty tractor trailer fleet in the US by 2040. The report notes the need to invest in charging and H_2 refueling, and especially the need for 1 MW chargers for long-haul applications. On average, ~ $4B investments are projected to be required annually to support the infrastructure development through 2050.
  https://theicct.org/publications/ze-tractor-trailer-fleet-us-hdvs-sept21

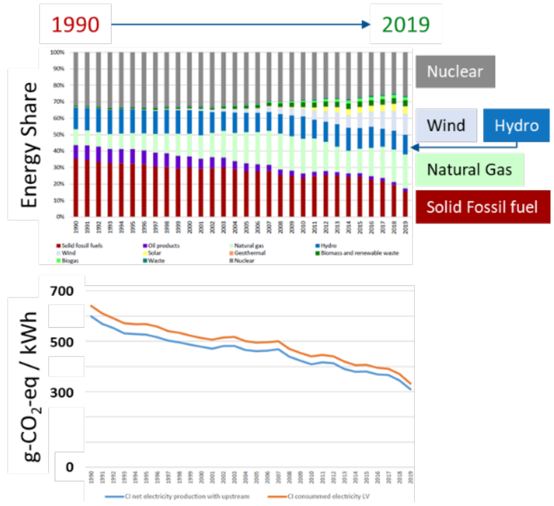
2030	2050
Charging points	Charging points
Total : ~ 125,000	Total : ~ 2.5M
1 MW : 10,500	1 MW : 220,000
H_2 refueling* : 220	H_2 refueling* : 6,900

*@4,800 kg/day

- What about charging speeds? While the 1MW chargers are not a reality yet, ABB has announced a new charger with a maximum output of 360 kW, capable of charging up to 4 vehicles at the same time or for the fastest charging speed for a single vehicle (provided they have the capability in the future). It will be available in Europe by the end of this year and in the US next year.
  https://new.abb.com/news/detail/82941/abb-launches-the-worlds-fastest-electric-car-charger

- On light-duty pickup trucks - Ford, in partnership with SK Innovation from Korea, will invest $11.4B to build 3 battery plants and an electric F-150 assembly plant in the US. The plants will come online in 2025 and ultimately enable 129 GWh of battery capacity. Assuming a 125kWh battery pack for the Ford Lightning, the added capacity can support a million electric pickups, roughly the average of the 2018 and 2019 F150 annual sales. Ford has increased its sales projections for the electric truck, and plans to build 15,000 model year 2022 Lightnings, ramping up to 80,000 in 2024 and then 160,000 EV trucks annually. To put it in perspective, that represents ~ 18% of the 900,000 F-150s sold in 2019 model year.
  https://www.theverge.com/2021/9/27/22696427/ford-ev-battery-factory-tennessee-kentucky-investment

- The benefits of electrification for reducing CO_2 emissions ultimately depend on the upstream emissions associated with the electricity generation. The European Commission has published a paper which quantifies the carbon intensity (CI) of electricity in Europe. The data shows that in the last 3 decades, emissions with electricity generation have reduced by ~ 50% on average, due a reduced dependence on coal and an increase in natural gas / renewables. The overall CI for EU-27 was ~ 334 g-CO_2/kWh. There is however a large spread amongst the various countries, with some < 30 g-CO_2/kWh and others at > 700 g-CO_2/kWh, pointing to the need for further decarbonization. https://doi.org/10.1016/j.apenergy.2021.117901



- While new technologies are being pursued and adopted for lowering CO2 from new vehicles, renewable fuels can help reduce the carbon footprint of the existing fleet. A new A new study points to the enhanced benefit of ethanol due to the displacement of aromatics in the gasoline blend. The carbon intensity of the fuel, when accounting for the reduced aromatics, was calculated at ~ 43.4 g/MJ, which roughly 50% lower compared to pure gasoline.
  https://www.transportenergystrategies.com/2021/09/29/new-study-blended-ethanol-has-a-43-4-g-mj-carbon-intensity-rating-or-lower-when-accounting-for-aromatics-reduction/
  At the SAE PF&L conference this month, Toyota discussed the concept of super lean burn (λ = 2.7) using ethanol, resulting in 50% NOx reduction.

Don't miss these upcoming events …

Aachen Colloquium on Sustainable Mobility, October 4th – 6th, 2021, Aachen, Germany and online.
https://www.aachener-kolloquium.de/en/

Argus Vehicle Emissions and DEF Summit USA, October 26th – 27th, Memphis, Tennessee and online.
https://www.argusmedia.com/en/conferences-events-listing/vehicle-emissions-def-usa

5th International FEV Conference, Zero CO_2 Mobility, November 16 – 17, 2021 in Aachen, Germany
https://www.fev.com/en/coming-up/fev-conferences/fev-conference-zero-co2-mobility/introduction.html