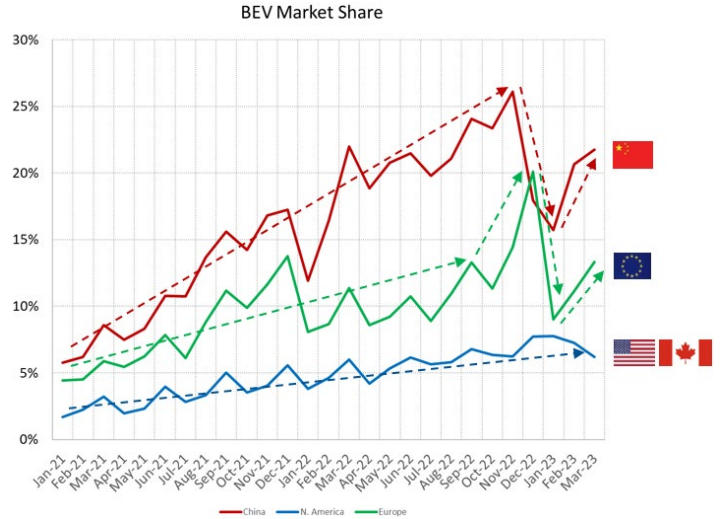


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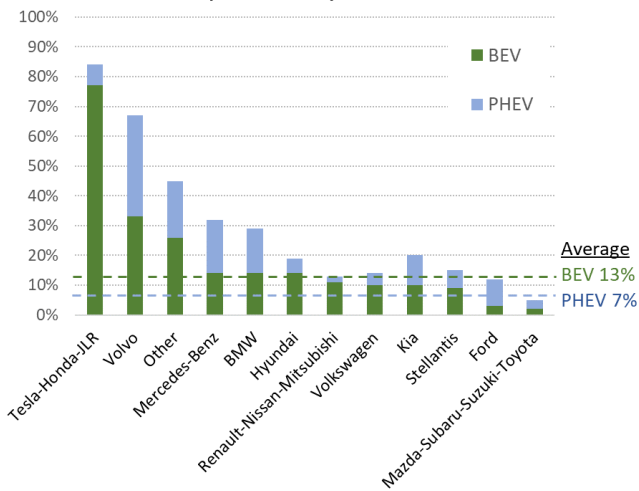
## Market Update

Sales of battery electric vehicles (BEVs) continue to grow but are still tied to incentives and market conditions. Following a significant uptick in sales in December, BEV sales dropped sharply in January and are beginning to recover the past months. (Data source: EV-Volumes)

The drop is possibly attributed to the pre-buys in December, tapering of incentives in Europe (especially in Germany), and economic inflationary headwinds leading to cautious spending by consumers.



Europe EV Share by OEM, Q1 2023



A report by the ICCT further elaborates on the share of EVs in Europe. On average, BEV share in Q1 2023 was 13% and PHEV share was 7% (so plug-ins are a little over 50% of total EVs). Note that the groups shown here are OEM pooling arrangements to meet the CO<sub>2</sub> requirements. All groups are on target to meet the CO<sub>2</sub> requirements.

## Regulations / Reports

### U.S. EPA Light- and Heavy Duty MY2027+ proposals – download summaries

The U.S. EPA published two proposals in April, the multi-pollutant proposal for MY 2027+ light- and medium-duty vehicles, and the Phase 3 GHG proposal for heavy-duty vehicles covering MY 2028 through 2032. The [light-duty](#) proposal covers both criteria pollutant emission tightening and GHG limits, while the [heavy-duty](#) is strictly a GHG rule. Both have been summarized and sent out separately, links above have downloadable summaries.

## Opposition to Euro 7 growing

Eight EU countries - France, Italy, the Czech Republic, Bulgaria, Hungary, Poland, Romania and Slovakia – have signed a [joint statement](#) opposing Euro 7 regulations for light-duty vehicles. Germany is not a signatory.

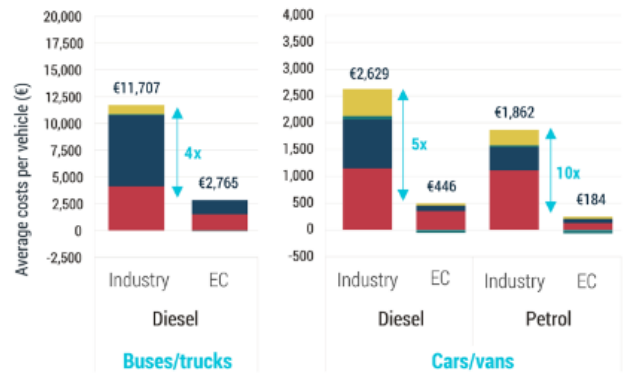
In the meantime, ACEA, the European OEM association, has published a new assessment which puts their estimate of the cost of Euro 7 compliance at 4 – 10 times the EU Commission estimates.

## DIRECT COSTS OF EURO 7

Source: Frontier Economics (2023)

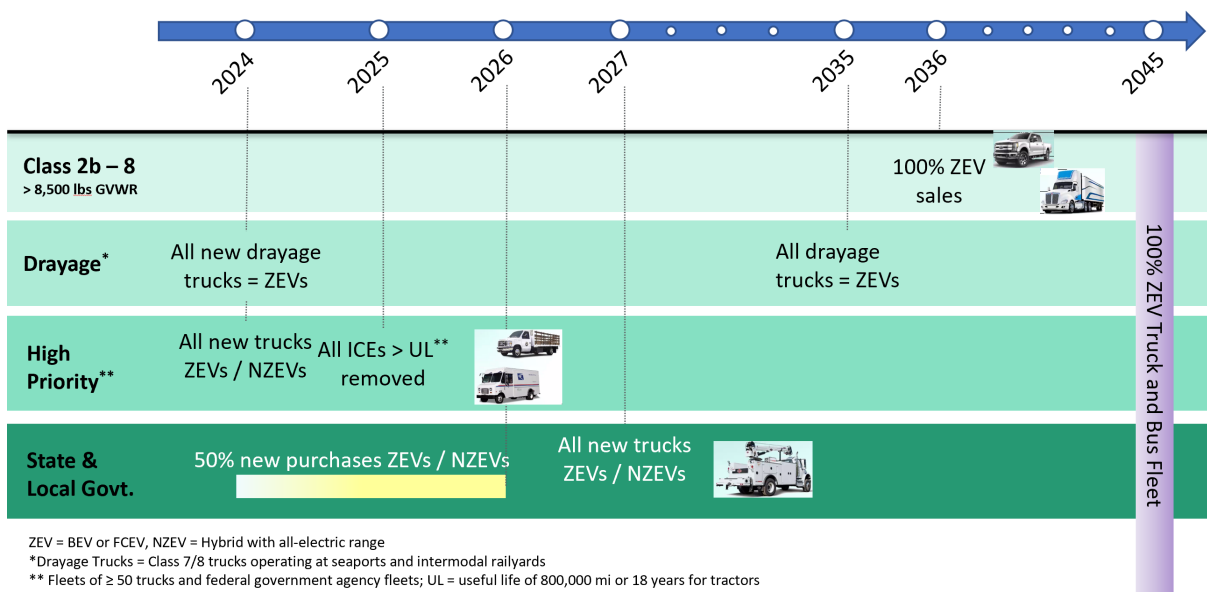
### Industry versus European Commission (EC) cost estimates

- Brake emissions
- Type-approval costs
- Investment costs
- Equipment costs



## California approves Advanced Clean Fleets Regulation requiring 100% HD ZEV sales by 2036

California Air Resources Board (CARB) [approved](#) the Advanced Clean Fleets regulation, which will require fleets to purchase an increasing fraction of heavy-duty vehicles to be ZEVs. The phase-in depends on the application, with all new drayage trucks to be ZEVs starting model year 2024, while all new long-haul sleeper trucks to be ZEVs by 2036. Existing ICE trucks can be used to their end of life. The HD ZEV fleet in California is [expected](#) to increase to ~ half a million by 2035 and 1.7M by 2050. Read here for a full [summary](#).



## IEA Renewable Energy Market update

The International Energy Agency has [published](#) its latest update on renewables worldwide. Some notes:

- In 2022, renewable energy capacity rose by ~13% to 340 GW. Solar PV added nearly net 220 GW, a 35% increase from 2021.
  - China accounted for almost half of all new renewable power capacity worldwide.
  - China and the EU accounted for >85% of the growth in annual PV capacity additions.
- 2023 will likely see the largest ever increase in renewable capacity of 440 GW.
- In 2024, cumulative renewable capacity is forecast to reach >4 500 GW, equal to the total power capacity of China and the United States combined

- The US is expected to see significant growth in renewable capacity additions, especially after 2024 due to the tax incentives in the IRA. Annual additions for solar and wind are set to increase by ~ 40% in 2023
- Biofuels displaced ~ 2 million barrels of oil equivalent per day (mboe/d) in 2022, equivalent to 4% of global transport sector oil demand. The increase is primarily being driven by emerging countries such as India and Argentina which rely in imports for crude oil. Biofuel demand is to expand by 11% by 2024.

## Electrification & Hydrogen

### Ford moves to gain advantage in EVs, but still much work to be done for cost parity with ICEs

Ford is expected to lose \$3B this year on its EV business, currently operating with a negative 40% margin. At an investor meeting, the company revealed that it needs to close a \$7B cost gap with rivals to remain competitive. CEO Farley [mentioned](#) that the cost parity target for a typical \$40,000 EV will be between 2030 and 2035 and will require more than just the IRA incentives. A move from NMC to LFP batteries seems to be a key enabler of cost reductions in the future.

Ford has taken two strategic steps recently to gain an edge in the EV space: (1) Signed a series of [deals](#) with lithium suppliers, which will address the key bottleneck of battery raw materials and allow their EVs to qualify for the IRA tax credits, and (2) [Announced](#) that next-generation Ford vehicles will be equipped with charging ports compatible with Tesla superchargers.

### Real-world range of HD trucks ~ 30% lower than advertised

A new [report](#) by the ICCT summarized the real-world performance of battery electric heavy-duty vehicles in China based on a database with information from over 9 million new energy vehicles.

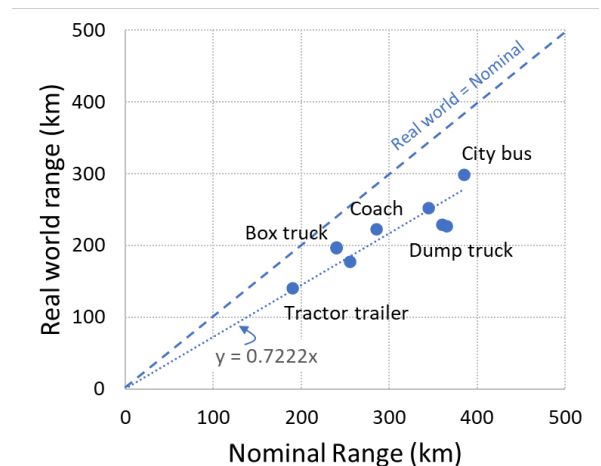
- While tractor-trailers in China drive on average 300 km per day, the BEV trucks were found to cover up to 140 km and therefore would require charging twice a day for normal operation.
- The electric range of the models was broadly ~ 30% lower than their nominal values. Energy consumption was found to exceed the nominal values by over 50% due to cooling and heating requirements.
- A “charging wherever possible” strategy seems to be used, where fleet operators are charging frequently and whenever possible during the day.

The analysis calls for the need for policymakers to require OEMs to provide real-world energy consumption and range over broad ambient conditions.

### Total cost of ownership study for long-haul trucks in the US

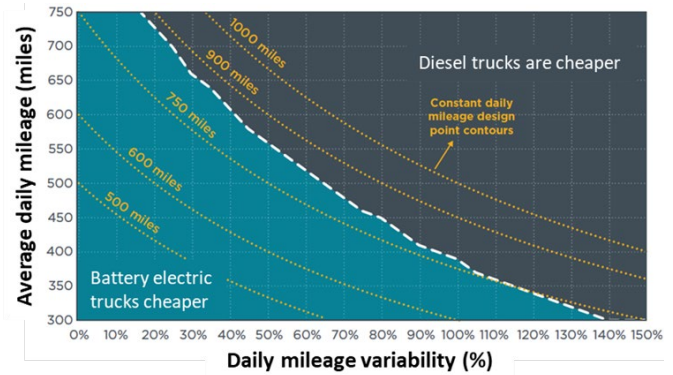
The recent U.S. EPA GHG Phase 3 proposal has relied significantly on analyzes done by the ICCT for the potential for electrification. One [study](#) compared the total cost of ownership (TCO) of diesels, battery electric, fuel cell and H<sub>2</sub>-ICE powered trucks for long-haul applications. It concludes that:

- The TCO of BEVs will be lower than diesels by 2030 for ~ 2/3<sup>rd</sup> of long-haul trucking.
- For H<sub>2</sub> fuel cell vehicles to be competitive with BEVs, the price of green H<sub>2</sub> needs to drop from current levels of ~ \$10-11/kg to \$3-6/kg. For H<sub>2</sub>-ICE, the price needs to drop further to ~\$2/kg to be at same TCO as the BEV trucks. (This is due to ~ 10% lower fuel economy of H<sub>2</sub>-ICE vs diesels)



The conclusions of such studies depend strongly on the assumptions made and it is not possible to summarize them here. But we mention two assumptions here –

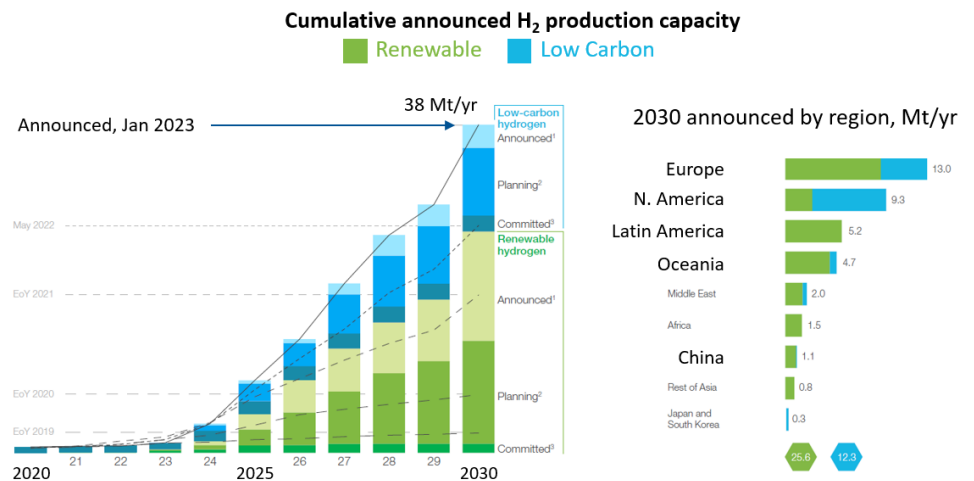
- (1) The price of BEV trucks will drop significantly from ~ \$450K today to ~ \$250K by 2030 due to reduced pack sizes with the availability of MW charging.
- (2) The battery pack size reduces from 1MWh today to 740 MWh by 2035 due to improvements in charging rates. The payload capacity for BEV trucks is ~9,000 lbs lower compared to diesels today (due to the battery pack), and with the battery size reduction, the gap reduces to ~1,000 lbs by 2035.



## Report on H<sub>2</sub> production

The Hydrogen Council, a 145-member group, along with McKinsey has published an update on the status of hydrogen production across the world.

- Almost 60% of the planned production is in US and Europe. Notably, China accounts for only ~ 3% of the planned capacity.
- Two third of the announced capacity is green H<sub>2</sub> while the rest is low carbon H<sub>2</sub> (presumably steam-methane reforming with CO<sub>2</sub> capture)
- The US currently plans to produce an additional ~ 9M tons. We have estimated in the past that this is equal to the current US H<sub>2</sub> consumption and will be sufficient to power a quarter of the long-haul fleet. At the recent SAE HD conference in Gothenburg, one of the keynote speakers mentioned that only ~ 10% of the H<sub>2</sub> produced will be allocated to transport (the rest going to fertilizers, steel, etc.).
- Finally, the report notes that there is big gap between announced capacity and reality, and that actual \$ commitments are greatly lagging the promised ones.



## Conference Summaries

### CRC 33<sup>rd</sup> Real World Emissions Workshop

A summary of this workshop, written by yours truly, is now available online as a [downloadable PDF](#).

### 2023 SAE Heavy-Duty Diesel Sustainable Transport Symposium

This conference was held on May 3-4, 2023 in Gothenburg, Sweden. The biennial event was back after a gap during Covid. The event covered a broad range of topics pertinent to heavy-duty transport: regulations, decarbonization technologies (electrification, fuel cells, H<sub>2</sub>-ICE), sustainability, and pathways for meeting upcoming Euro 7 regulations, to name a few. See [DieselNet](#) for a good summary.

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## Upcoming Conferences

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**DOE Annual Merit Review, June 12<sup>th</sup> – 15<sup>th</sup>, online**

<https://www.energy.gov/eere/vehicles/vehicle-technologies-annual-merit-review>

**Congress PTNSS 2023, June 19<sup>th</sup> – 21<sup>st</sup>, Wroclaw, Poland**

<https://ptnss.pl/en/congress-ptnss-2023-eng/>

**24<sup>th</sup> ETH-Conference on Combustion Generated Nanoparticles, June 20<sup>th</sup> – 22<sup>nd</sup>, Zurich**

<https://www.nanoparticles.ch/>

**23<sup>rd</sup> Stuttgart International Symposium, July 4<sup>th</sup> – 5<sup>th</sup>, Stuttgart**

<https://www.fkfs-veranstaltungen.de/en/events/stuttgart-symposium>