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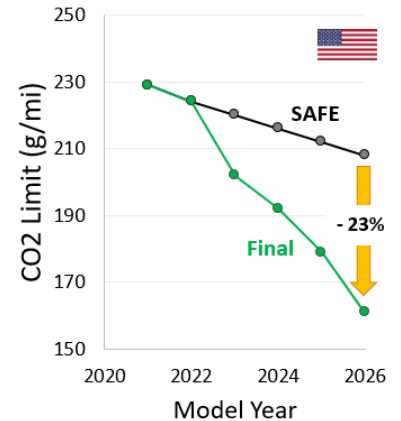
### Regulatory Update

#### US fuel economy standards for MY 2023 - 2026 light-duty vehicles

The US EPA [revised](#) the tailpipe CO<sub>2</sub> standards for model years (MY) 2023 – 2026 passenger cars and light-duty trucks. On average, this will require fleet averaged annual reductions of CO<sub>2</sub> by 7%. Compared to the previous Safer Affordable Fuel-Efficient (SAFE) rule, these new standards will result in 23% fewer CO<sub>2</sub> emissions by MY2026, and result in an averaged 55 miles per gallon fuel economy that year.

Electric and plug-in hybrid vehicles get multiplier credits of 1.5 and 1.3, respectively, but are phased out starting 2025. Also, pick-ups get credits for hybridization.

The EPA estimates that these CO<sub>2</sub> standards will result in 17% battery electric vehicles annual sales by MY 2026.

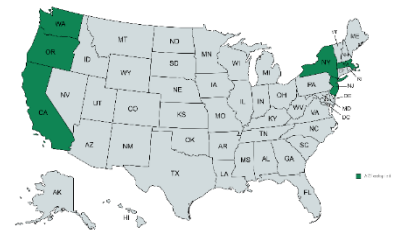


#### NHTSA reinstates California’s authority to set fuel economy and ZEV standards

The National Highway Traffic Safety Administration (NHTSA) has signed a final [rule](#) to repeal the SAFE I Rule by the previous administration, which effectively revoked California’s authority to set its own greenhouse gas (GHG) and zero-emission vehicle (ZEV) standards.

#### More US States adopt California’s Advanced Clean Trucks Rule

In December, [New Jersey](#), [New York](#) and [Massachusetts](#) announced the adoption of California’s Advanced Clean Trucks regulation which requires increasing fraction of new medium and heavy-duty truck sales to be fully electric, starting model year 2024. Previously, Washington state and Oregon have also adopted this regulation, bringing the total number of states having adopted ACT to 6, including California.



#### SAE Govt. Industry Meeting, Jan 19<sup>th</sup> – 21<sup>st</sup>, 2022, Washington DC

- Government representatives conveyed an “all hands on deck” approach for reaching full electrification, through billions of dollars in funding for charging infrastructure, battery supply chain, end customer incentives, and transitioning the federal fleet of >600,000 vehicles to all-electric. Environmental justice is high priority, with the goal of ensuring that people from all walks of life get the benefits of cleaner vehicles.
- The industry is responding. New investments are going towards electrification, while preserving the ICEs which are delivering profits today. However, speakers cautioned that infrastructure is significantly lagging (especially for heavy-duty) and that the market still needs incentives.
- Heavy-duty vehicles have unique challenges and were discussed separately. Battery costs for heavy-duty vehicles are still > \$200 - 300 / kWh, much higher than the \$100 / kWh cited for light-duty. Upfront cost can be as high as 4X compared to diesels. Diesels are expected to play a role for a longer time, and efforts to reduce NO<sub>x</sub> were highlighted.

- EPA confirmed their plans for multi-pollutant (GHG + criteria pollutant) rulemakings for both light- and heavy-duty vehicles. For MY2027+ LD vehicles, proposal will be made by Q1 2023 and final rule by Q1 2024. For HD trucks, NHTSA will be proposing new fuel economy standards for beyond 2030.

Find a downloadable summary of the meeting [here](#).

## Market Update

### Hybrids and electrics reach record sales in the US

In 2021, electrified powertrains [gained](#) significant market share in the US. Notably, gasoline hybrid sales increased by 76% vs 2020. The recently revised fuel economy standards (see above) will only accelerate this trend.

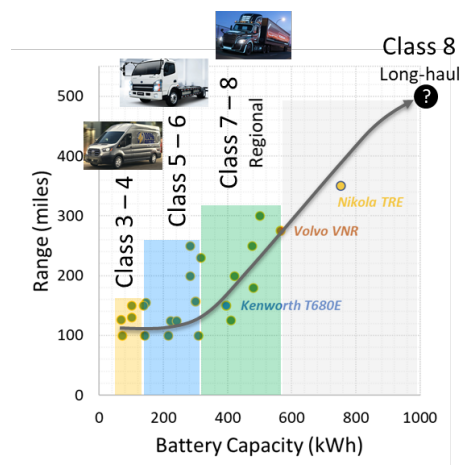
	Sales	% share of new sales
Hybrids	801,550	5%
PHEVs + BEVs	434,879	3%

### GM electric light-duty pick-up truck

At the CES, GM [announced](#) details on the Chevy Silverado EV. Specs include an estimated 400-mile range, charging rate up to 350 kW, 664 hp (max), towing capacity up to 10,000 lbs.

### Class 8 electric trucks

- Volvo is now offering an enhanced version of its Class 8 all-electric [VNR](#) truck for the North American market. The battery capacity has more than doubled to 565 kWh, extending the range from 150 to 275 miles.
- Kenworth is offering an electric semi-truck, [T680E](#), with a 150-mile range using a 396 kWh battery pack. The truck is available in day cab as tractor or straight truck, with an 82,000 lb. gross vehicle weight rating. Charging can be done in 3.3 hours at maximum charging rate of 120 kW.
- Nikola's TRE battery electric truck has obtained California's [approval](#) as a ZEV and the related incentive (\$120K) for new purchases. The truck offers 350 mile range using a 753 kWh pack.



### Electrification of construction equipment

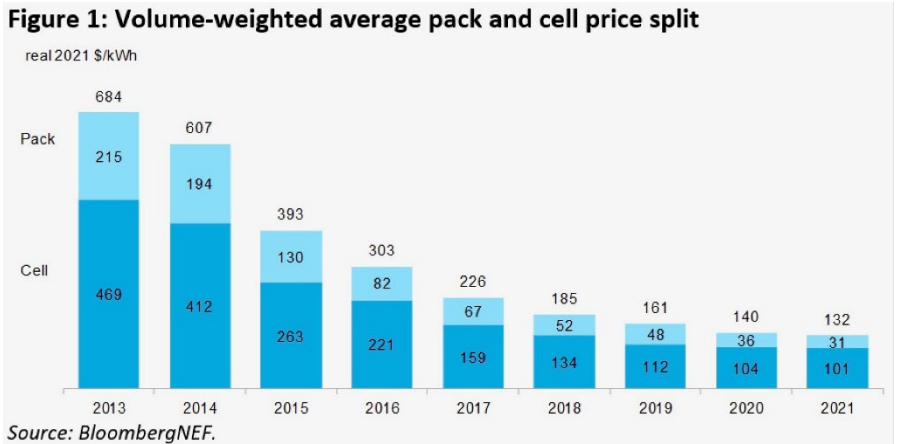
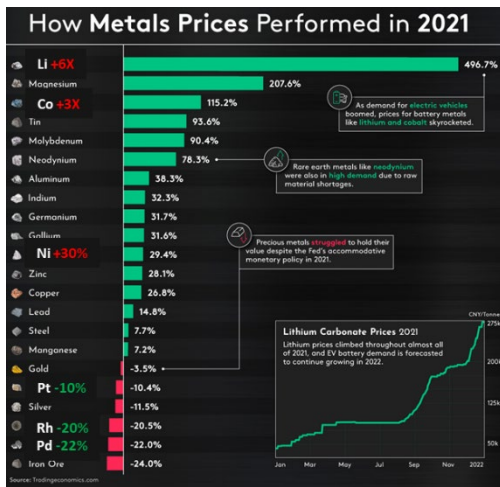
Bobcat [introduced](#) the world's first commercial all-electric compact track loader. In the non-road equipment, electrification typically refers to physical movement while the actual working elements are powered using hydraulics. The Bobcat T7X is however a truly full electric in that even the working parts are powered using motors and actuators. The battery is 62 kW and provides up to 4 hours of continuous operation (so presumably the pack is 248 kWh).

### Raw material price increase and phase out of subsidies for NEVs in China

Metal prices [changed](#) significantly in 2021, in response to the increased demand for batteries as well as overall reduced vehicle sales as the industry grapples with supply chain issues. Noteworthy to low emission technologies is the jump in price for lithium (6-fold) and cobalt (3-fold), and the reduction in PGMs used in catalytic converters (10 – 20%).

Battery pack prices [fell](#) by ~ 6% in 2021 to \$132/kWh (note : pack prices are significantly higher for heavy-duty vehicles). But these are expected to increase in 2022 following the increase in metal prices. Note that these prices are an average and there are important differences across chemistries and regions (e.g. prices in US and EU are 40% and 60% higher than in China).

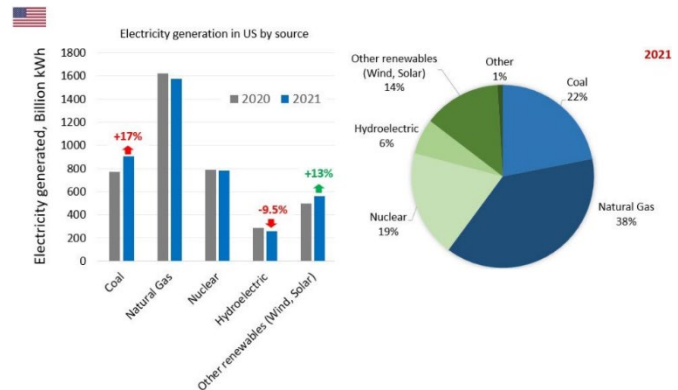
Figure credits – VisualCapitalist.com (left) and BloombergNEF (right)



Starting 2020, China has gradually reduced subsidies for the new energy vehicles (mostly electric) by 10% each year and announced that it will complete phase out subsidies by the end of the year.

### GHG emissions and coal-based electricity generation increased in 2021

In 2021, the global economy moved towards recovery to pre-pandemic levels, but greenhouse gas emissions also increased as expected. In the US, GHG emissions are estimated to increase by 6.2% relative to 2020. According to an IEA report, solar and wind-based electricity generation in the US increased by 13%, but this was offset by a 17% increase in coal-based electricity generation, the first increase since 2014. China and India were the other major countries which increased coal consumption.

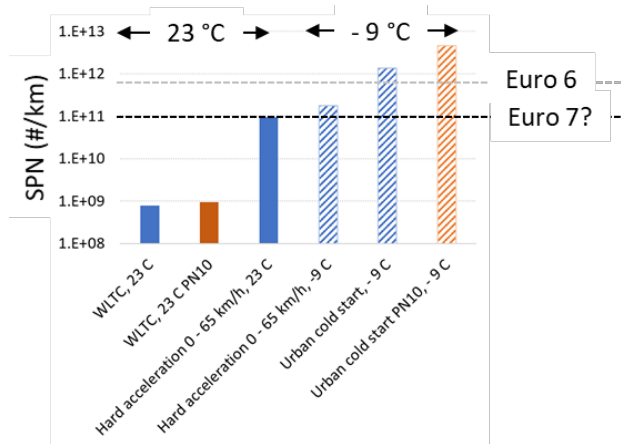


### Technology Update

#### Advanced GPF performance under “Euro 7” like conditions measured

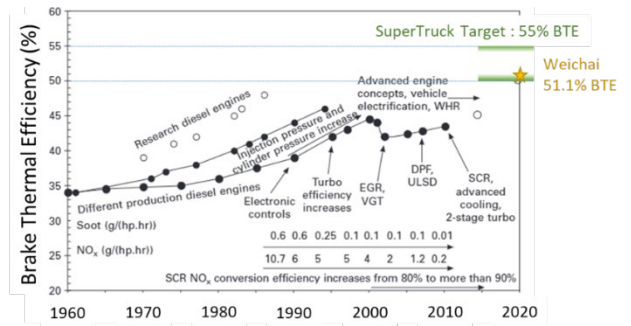
A paper by the European Commission has evaluated an advanced bare GPF under various challenging driving conditions – sub-zero temperatures, hard accelerations, urban driving, etc. – and including particle count down to 10 nm. It was found that the GPF gave very high filtration, resulting in  $PN < 1 \times 10^{11}$  #/km for most conditions. But particle formation or growth downstream of the GPF due to re-nucleation / adsorption of PAHs can result in a significant overcounting of solid particle number. The use of a catalytic stripper which oxidizes these PAHs is recommended for future regulations.

<https://www.mdpi.com/2073-4344/12/1/70>



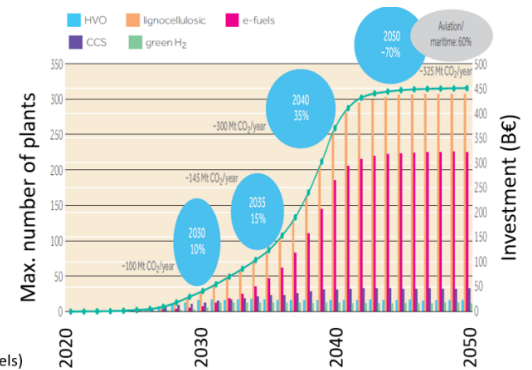
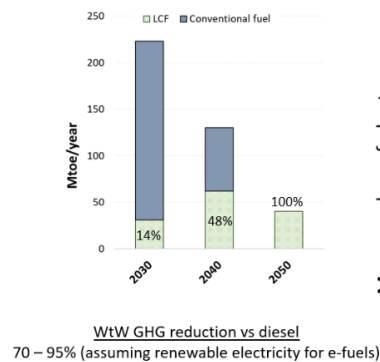
## 51% BTE diesel engine

Weichai had [announced](#) a 50% brake thermal efficiency (BTE) engine last year. Early in Jan 2022, Weichai has announced their best diesel engine achieves 51% BTE. To put this in perspective, current commercial engines have a BTE of ~ 45%, and Weichai expects the 51% BTE engine to deliver a 10% improved fuel economy. The US DOE SuperTruck II program, which ends this year, set a target of 55% BTE which has been demonstrated by some of the participants. It will take a few years before such engines are commercialized.



## Low carbon liquid fuels

A new [report](#) by Concawe assesses the GHG reduction via the use of low carbon liquid fuels (LCFs) for the transportation sector, and the investments needed. In one scenario which assumes LCFs being used only for heavy-duty, maritime and aviation beyond 2040, 70% reduction in GHG emissions is predicted through the low carbon fuels combines with more efficient powertrains.



## Work-from-home for farmers ?!

At the CES 2022, John Deere announced the first [fully autonomous tractor](#), which can detect obstacles and differentiate between weeds and crops (and remove the former) as it navigates the field. The tractor is equipped with six pairs of stereo cameras and machine learning algorithms to calculate its location and neural network based classification of pixels to help decide whether to continue or stop due to an obstacle. The farmer can monitor the equipment with an app, which will provide live images, videos and data and help control the speed remotely.



## Don't miss these upcoming events in 2022 ...

**31<sup>st</sup> CRC Real World Emissions Workshop, March 13<sup>th</sup> – 17<sup>th</sup>, San Diego, California**

<https://crcao.org/2022-31st-crc-real-world-emissions-workshop/>

**11<sup>th</sup> Annual PEMS Conference, March 17<sup>th</sup> – 18<sup>th</sup>, Riverside, California**

<https://www.cert.ucr.edu/pems>

**SAE On-Board Diagnostics Digital Summit – Europe, March 15<sup>th</sup> – 17<sup>th</sup>, online**

<https://www.sae.org/attend/obd-europe>

**SAE World Congress, April 5<sup>th</sup> – 7<sup>th</sup>, Detroit and online**

<https://www.sae.org/attend/wcx>