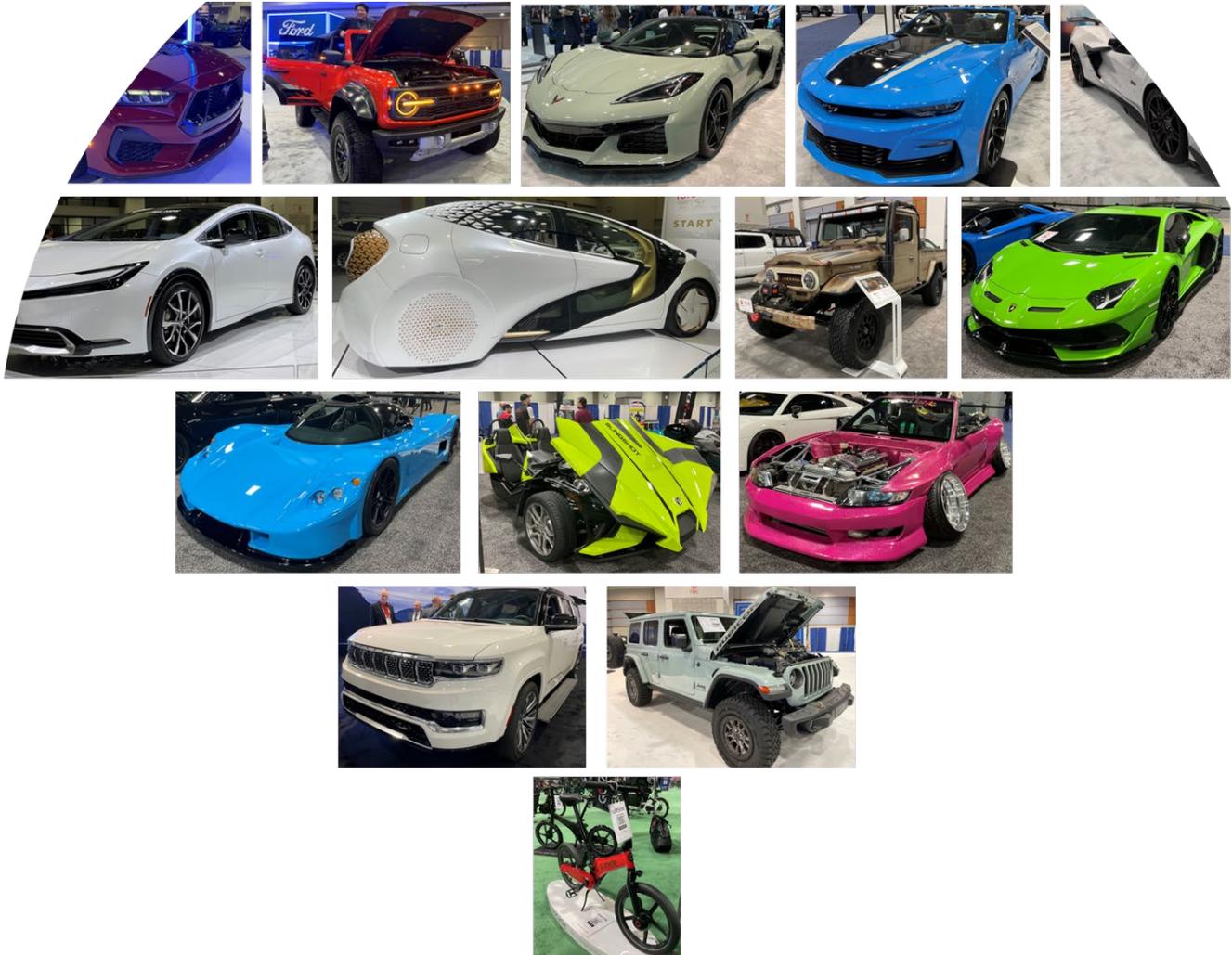


5-Min Monthly Read - January 2023

Sign-up and previous newsletters: <https://mobilitynotes.com/home/newsletters/>

Pictures taken at the Washington DC Auto Show, Jan 2023 – what’s your favorite?

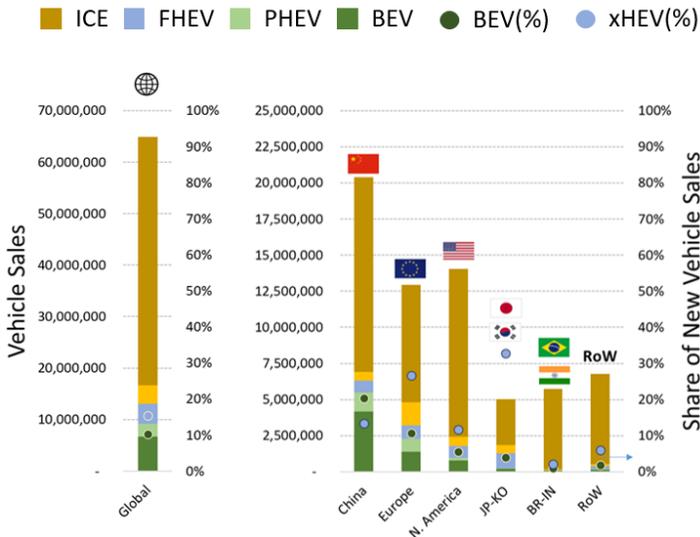


Market Update

- In 2022, globally, 1 out of every 10 cars sold was purely battery electric and 1 out of every 7 cars was a hybrid
- China is leading pure BEV sales, one in every 5 cars sold was a pure battery electric
- Hybrids have an especially high share in Europe (> 25%) and Japan-Korea (> 30% - primarily in Japan)

Source : EV-Volumes

New Vehicle Sales by Powertrain : Jan - Nov 2022



Region	BEV Share Jan – Nov 2022	Hybrid Share* Jan – Nov 2022
Global	10.3%	15.4%
China	20.4%	13.4%
Europe	10.6%	26.6%
N. America	5.6%	11.7%
Japan-Korea	3.9%	32.8%
Brazil-India	0.9%	2.1%
RoW	1.9%	5.9%

*Mild + Full + Plug-in hybrids

Regulations / Reports

If you missed it – EPA regulations towards end of 2022 : [EPA 2027 HD Low NOx](#) | [NAAQS](#)

Towards the end of 2022, two important new standards were announced: the EPA engine standards for MY 2027+ heavy-duty vehicles and the EPA proposal to revise the annual PM2.5 national ambient air quality standard (NAAQS) from 12 ug/m³ (micrograms per cubic meter) to a level of 9 – 10 ug/m³.

Will CARB align with EPA federal standards for HD Low NOx? Not clear, but there is [criticism](#) of the significantly weaker standards by EPA at lower temperatures. Table below taken from the EPA rule shows that the limits at 5 °C are ~ 1.6 times higher compared to those at room temperature.

TABLE III-18—TEMPERATURE ADJUSTMENTS TO THE OFF-CYCLE NO_x STANDARDS

Service class	Applicability	Bin	NO _x standard at 25 °C	NO _x standard at 5 °C	Applicable unit
All	All	1	10	^a 15	g/hr.
Light HDE	Certification & In-use	2	58	^a 102	mg/hp-hr.
Medium and Heavy HDE	Certification	2	58	^a 102	mg/hp-hr.
Medium and Heavy HDE	In-Use	2	^a 73	^a 117	mg/hp-hr.

^a The Bin 1 and Bin 2 ambient temperature adjustment and the NO_x compliance allowance for in-use testing do not scale with the FEL_{FTPNO_x}.

U.S. National Blueprint for Transportation Decarbonization

Several US government agencies, the Department of Energy (DOE), the Department of Transportation (DOT), the EPA, and the Department of Housing and Urban Development (HUD) jointly published a blueprint for decarbonizing the transportation sector. As seen in the table, the strategy envisions a battery electric future for light-duty vehicles, while hydrogen is expected to play a key role in long-haul trucking. Sustainable fuels are expected to decarbonize the “hard-to-electrify” segments such as rail and marine.

	BATTERY/ELECTRIC	HYDROGEN	SUSTAINABLE LIQUID FUELS
Light Duty Vehicles (49%)*	3 icons	—	TBD
Medium, Short-Haul Heavy Trucks & Buses (~14%)	2 icons	1 icon	1 icon
Long-Haul Heavy Trucks (~7%)	1 icon	3 icons	2 icons
Off-road (10%)	2 icons	1 icon	1 icon
Rail (2%)	2 icons	2 icons	2 icons
Maritime (3%)	1 icon	2 icons	2 icons
Aviation (11%)	1 icon	1 icon	2 icons
Pipelines (4%)	2 icons	TBD	TBD
Additional Opportunities	<ul style="list-style-type: none"> Stationary battery use Grid support (managed EV charging) 	<ul style="list-style-type: none"> Heavy industries Grid support Feedstock for chemicals and fuels 	<ul style="list-style-type: none"> Decarbonize plastics/chemicals Bio-products
RD&D Priorities	<ul style="list-style-type: none"> National battery strategy Charging infrastructure Grid integration Battery recycling 	<ul style="list-style-type: none"> Electrolyzer costs Fuel cell durability and cost Clean hydrogen infrastructure 	<ul style="list-style-type: none"> Multiple cost-effective drop in sustainable fuels Reduce ethanol carbon intensity Bioenergy scale-up

* All emissions shares are for 2019

† Includes hydrogen for ammonia and methanol

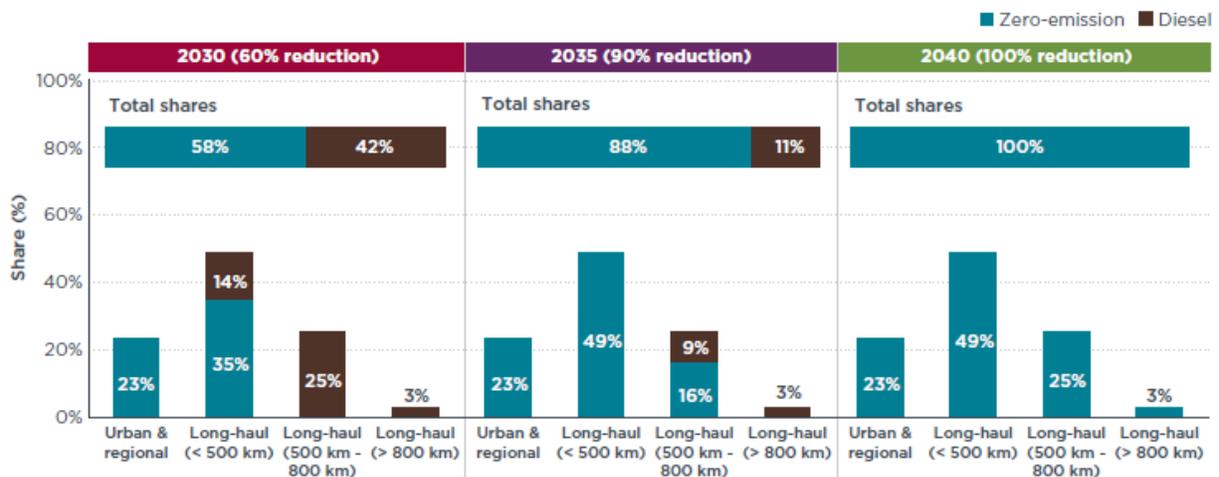
ACEA report on in-use fleet in Europe

The European Automobile Manufacturers’ Association (ACEA) has published a [report](#) on the state of the vehicle fleet in Europe. In 2021, there were ~ 294 million passenger cars, 36 million light commercial vehicles (< 3.5 tons), 7.3 million medium and heavy commercial vehicles > 3.5 tons, and ~ 820,000 buses. The passenger car fleet grew by ~ 1.2%, while the commercial vehicles and buses grew by 2.2%, relative to 2020. Electric vehicles are < 1.5% of the car fleet while diesel is still the dominant fuel (> 90% share) for the commercial vehicles. The EU has 567 cars per 1,000 inhabitants.

ICCT report on HD transport decarbonization

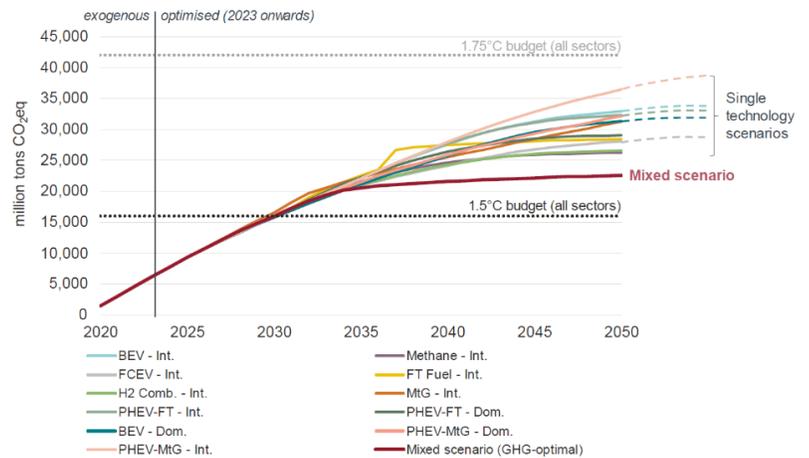
Current heavy-duty vehicle standards in Europe require a reduction in CO₂ emissions of 30% by the end of the decade (not all classes are regulated). A new [report](#) published by the ICCT analyzes pathways to increase the target to 60% by 2030, 90% by 2035 and 100% (only ZEV sales) by 2040. Some conclusions of the study:

- Long-haul trucks operating > 500 km are expensive to fully electrify by 2030-35 and will require a continued improvement in diesel engine efficiency. Around 70% of trucks in Europe travel < 500 km per day.
- With advanced technologies, diesels can potentially reduce CO₂ emissions by ~ 22-40% by 2030, but beyond a reduction of 18.5% for long-haul diesel tractors, a shift to electrification will be most cost-effective.
- By 2030, the ICCT scenario of 60% CO₂ reduction would require ~ 57% BEV share and increase compliance cost by €12,473 per vehicle, but also provide a €35,000 – 110,000 cost savings due to reduced fuel costs.



FVV study calls for pursuing multiple technologies for fastest decarbonization

A latest comprehensive study by [FVV](#) evaluated 11 carbon-neutral pathways to achieve decarbonization of the transport sector. The study concluded that a mix of energy carrier and powertrain technology pathways can help Europe achieve carbon-neutral transport by 2039, while reliance on BEVs alone achieves 76% reduction in fossil fuel consumption by 2050. The study questions the 2035 ICE ban in Europe since it finds that leading to higher GHG emissions relative to keeping the option of adding synthetic fuels.



Bloomberg New Energy Outlook 2022

According to Bloomberg's [New Energy Outlook 2022](#), in the "economic transition scenario" driven by market forces, CO₂ emissions from the global power sector could reduce by 57% by 2050, by when wind and solar will supply 65% of the electricity demand. Transport is the only other sector which will reduce emissions by 22% due to electrification, or 13% after accounting for emissions from power generation. The on-road transport sector will require an additional 5,640 TWh of power demand by 2050, which will be 14% of global electricity consumption. Taken together, the two sectors reduce CO₂ emissions by 50% compared to the business-as-usual, but still result in a 2.6 °C global warming by 2050.

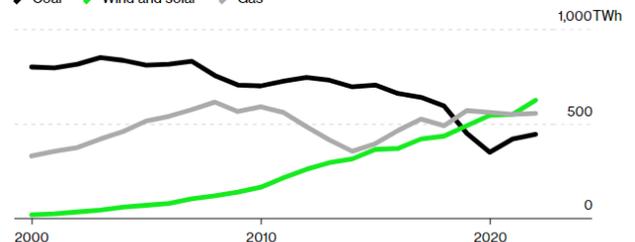
Renewable power generation is growing, a recent [report](#) shows that in Europe, more electricity was produced using renewable sources than natural gas for the first time.

To reach net zero emissions by 2050 will require additional actions, including a more rapid transition away to renewable power generation, carbon capture and storage (growing from 1.7 Gt in 2030 to > 7 Gt in 2050), use of bioenergy and increasing use of hydrogen in the hard-to-electrify segments such as aviation, shipping, steel industry etc.

EU Solar and Wind Power Overtook Gas in the Power Mix in 2022

Renewables will keep pushing out fossil fuels as wind and solar grow

Coal Wind and solar Gas



Source: Ember

Electrification / Hydrogen

New battery investments in the US

- Tesla will be investing > \$3.6B to expand the Nevada Gigafactory, adding 100 GWh 4680 cell manufacturing capacity, and producing the fully electric Semi in large volumes. Details are emerging on the Semi battery, one [report](#) puts it at 900 kWh, which translates to 1.8 kWh/mi.
- Honda and LG Energy Solution are jointly [investing](#) \$3.5B in a new battery plant which will produce ~ 40 GWh of batteries by end of 2025 and supply Honda's electric vehicles sold in N. America.

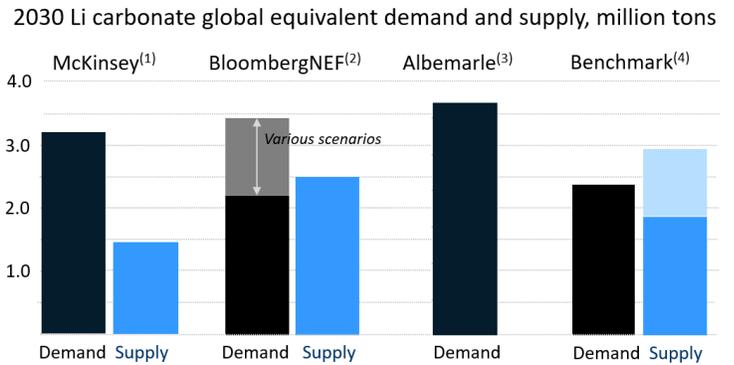
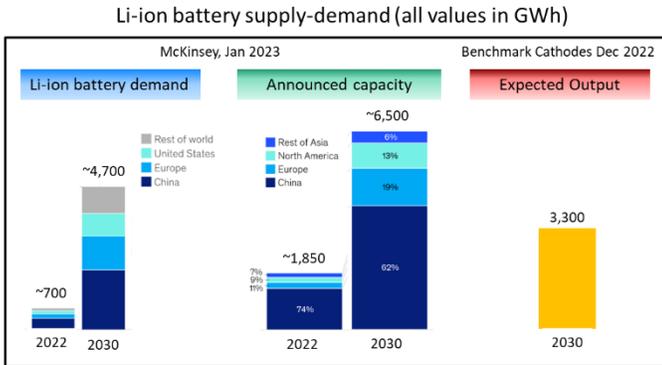


UK battery supply troubles

Britishvolt, a battery startup in the UK [collapsed](#), reducing UK's planned cell capacity to 2031 by 43%. The remaining capacity consists of a small < 2 GWh plant by Nissan and another the OEM plans to build with China-based Envision with up to 35 GWh capacity. This is a setback to UK's ambitions of eliminating new combustion engine cars by 2030.

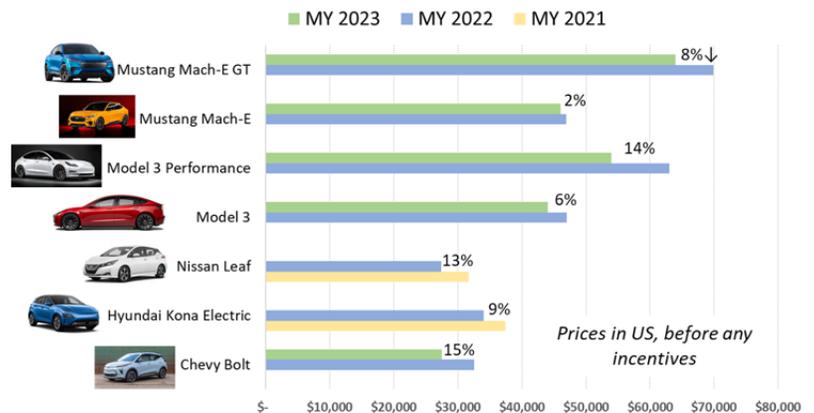
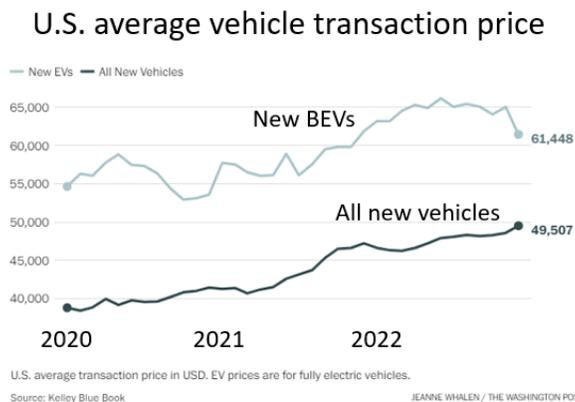
Lithium projected to fall short of demand without further mining project developments

A report by [McKinsey](#) predicts 4.7 TWh of Li-ion battery demand by 2030, ~ 7X that required in 2022, of which 40% would be consumed by China alone and >90% would serve the mobility sector. The nameplate announced capacity stands at 6.5 TWh in 2030, exceeding the demand, but the authors are skeptical of all production coming online. Benchmark Mineral Intelligence predicted an output of 3.3 TWh in the Cathodes conference in December 2022, which puts the utilization of the capacity at ~ 50% and result in a shortfall of ~ 1.4 TWh batteries.



The McKinsey report warns that without additional investments in mining or battery technology improvements, the projected 2030 lithium supply could fall short of the demand by 55%. BloombergNEF, in their "[Transition Metals Outlook 2023](#)" report, also predict a shortfall to reach the net-zero scenario. Albemarle, the lithium producer, raised its forecast for lithium demand to 3.7M tons. Benchmark Mineral predicts a 44% lower demand at 2.4M tons and yet [opined](#) that "*the lithium industry is not on course to even meet the most modest of demand projections*".

Price gap between EVs and ICEs narrowing? A major drawback for EVs today is their higher price point compared to ICE vehicles. The average transaction price on a new EV was ~ 24% higher compared to all new vehicles near the end of 2022. Recently however, Tesla and Ford have closed some of the gap and have announced price cuts on their EV offerings. Note that the price reduction could also help some models be eligible for incentives in the Inflation Reduction Act (IRA).



India's Green Hydrogen strategy

The Indian government has [approved](#) a "National Green Hydrogen Mission" which targets, by 2030, green H₂ production capacity of > 5 million metric tons per year along with the necessary additional renewable energy capacity of ~ 125 GW. A total of ~ \$2B will be invested and used to incentivize domestic manufacturing of electrolyzers and H₂ production. India consumes ~ 8 – 9M tons of H₂ annually, 80% of which is used for fertilizers and fuel desulfurization.

Engines and Fuels

Mazda new engines : rotary engine and plug-in hybrid range extenders

Mazda [unveiled](#) a plug-in hybrid variant of its electric vehicle, the MX-30 e-Skyactiv R-EV, which pairs a newly developed rotary engine with a small 17.8 kWh battery. The direct injected 0.83L rotary engine operates at CR 11.9 and has EGR, TWC and a GPF for compliance with Euro 6d standards. The all-electric range is 85 km (~ 46 miles on US cycle), while the engine serves as a generator to recharge the battery providing an overall driving range of over 350 miles. The vehicle is currently launched for the European market only and has a fuel consumption is 1L/100km – 235 mpg effective – plus 17.5 kWh/100-km, both measured on the WLTP. Here a [video](#) which gives a good overview of the engine and battery layout. Mazda also [introduced](#) the new 2024 CX-90 which has a new 3.3L e-Skyactiv turbo engine with a mild hybrid system, and a plug-in hybrid version with a 2.5L 4-cylinder engine paired with the same 17.8 kWh battery mentioned above.



World's first ammonia powered zero tailpipe emitting semi-truck

[Amogy](#) retrofitted a 2018 Freightliner Cascadia to run on ammonia and tested the truck for several hours on the Stony Brook University campus. Eight-minute long refueling provided 900 kWh of on-board net electric energy. The technology includes an on-board catalyst which cracks ammonia to hydrogen for use with a fuel cell. While conversion of H₂ to ammonia and back has its inefficiencies, the main advantage of on-board ammonia is that it is easier to liquefy, provides a higher density carrier (vs. H₂) and addresses some of the issues with transporting hydrogen over long distances.

GM investing \$854M for V-8 engine production

GM has [announced](#) plans to invest in additional production of V-8 engines at four US sites. The engines will be applied for full-size trucks and SUVs.

Renewable fuel capacity estimated to reach > 16 billion gallons by 2030

A report by Bloomberg projects renewable fuels – mostly renewable diesel for on-road applications – to increase nearly three-fold from 5.5 billion gallons in 2022 to ~ 16 billion gallons by 2030. The upcoming projects will also address jet fuel and naphtha. Most (99%) of the production utilizes hydro-processing but alternatives such as Fischer-Tropsch are expected to contribute up to 10% towards the end of the decade.

Upcoming Conferences

TMC's 2023 Annual Meeting & Transportation Technology Exhibition, Feb 27th – March 2nd, Orlando

<https://tmcannual.trucking.org/>

Future Propulsion Conference, March 2nd – 3rd, Solihull, UK

<https://fpc-event.co.uk/>

On-Board Diagnostics Symposium-Europe, March 14th – 16th, 2023, Prague, Czech Republic

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

40th International Battery Seminar, March 20th – 23rd, Orlando, Florida

<https://www.internationalbatteryseminar.com/>

33rd CRC Real World Emissions Workshop, March 26th – 29th, Long Beach, California

<https://crcao.org/33rd-crc-real-world-emissions-workshop/>

2023 Onboard Sensing, Analysis, and Reporting (OSAR) Conference, March 30th – 31st, Riverside, California

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