

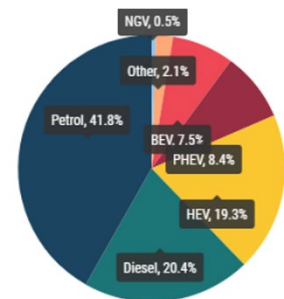
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Market Update

In Europe, hybrids now enjoy the same market share as diesels. Vehicle registration data for second quarter of 2021 is available and shows that electrics and hybrids are rapidly gaining share in Europe and China. In Europe, the registration of battery electric vehicles more than doubled from 3.5% in Q2 2020 to 7.5%. And one in every 4 cars is now a hybrid: plug-in hybrids sales are at 8.4% while other hybrids are at 19.3%. Petrol and diesel sales increased compared to last year (Covid impact), but overall market share of diesel is now at 20.4%.

<https://www.acea.auto/fuel-pc/fuel-types-of-new-cars-battery-electric-7-5-hybrid-19-3-petrol-41-8-market-share-in-q2-2021/>

Car registration: Q2 2021, Europe



Globally, 2.6 million electrically chargeable (pure EV + plug-in electric) vehicles were sold in the first half of 2021, with 87% of these sold in Europe and China:

Market	Sales of EVs and PHEVs combined	% of new vehicles sold
Europe	1 million	15%
China	1.1 million	12%
US	250,000	3%

<https://www.canalys.com/newsroom/global-electric-vehicle-sales-up-160-in-h1-2021-despite-supply-constraints?time=1630900595>

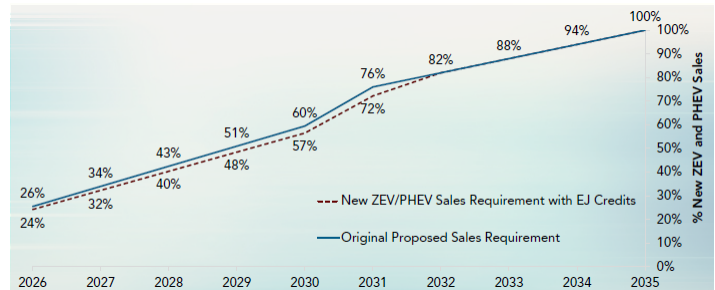
In the same first half of the year, 105 GWh of batteries were deployed (for automotive), which puts the average battery size at ~ 40 kWh (average of both small batteries for plug-ins and large for full EVs). CATL and LG Energy were leading the supply, with each making ~ 28 GWh of batteries.

<https://insideevs.com/news/527554/global-xev-battery-market-2021h1/>

Regulatory Update

- California's Air Resources Board (CARB) held another workshop to discuss the development of the Advanced Clean Cars II regulations for reducing criteria and greenhouse gas emissions from light- and medium-duty vehicles. A key addition to the previous proposal is a provision for Environmental Justice (EJ) credits for making ZEVs and plug-in hybrid vehicles affordable to underserved communities. Discounted ZEVs/PHEVs will earn up to 0.5 credits for community-based programs and 0.1 credits will be granted for "used" ZEV purchases for personal use. Credit accumulation will be available from model years 2026 through 2031 and will have a 5% cap. These credits are expected to reduce the overall market uptake of ZEV/PHEVs by 2 – 4% through this decade.

<https://ww2.arb.ca.gov/events/public-workshop-advanced-clean-cars-ii-0>



Here is a recent article which gives a perspective on equity when transitioning to electric mobility. EV buyers in California have a mean income of > \$190,000, 81% own a home (important for charging), 81% are college graduates, 75% are male and 55% are white (vs. 41% white for conventional cars). The sales weighted MSRP for electric cars has increased from ~ \$42K in 2012 to ~ \$62K in 2021 despite the significant reduction in battery costs.

<https://sciencepolicyreview.org/2021/08/equity-transition-electric-vehicles/>

- India has set a target of becoming energy independent by 2047 (100 years following its independence) through a series of measures including electrification of transport, 20% ethanol fuel, and increased use of natural gas.
<https://energy.economictimes.indiatimes.com/news/renewable/pm-modi-sets-2047-target-for-india-to-become-energy-independent/85347960>
 - An announcement was made that the government will make it mandatory for OEMs to offer vehicles running on 100% biofuels within the next 6 months.
 - Also announced is a vehicle scrappage policy, to be implemented starting October 2021. Personal vehicles over 15 years old and commercial over 10 years old will have to undergo a roadworthiness test (safety and pollution) and if found unfit, the owner will have to scrap the vehicle in return for monetary incentives.

Technology Update

Spotlight on Hydrogen

August was a "hydrogen" month with various announcements ranging from green H₂ production to utilization in heavy-duty transportation – trucks and trains – and even steel manufacturing:

- New national policies were put in place by various countries on H₂ infrastructure by India, the UK, Russia, Colombia and the yet-to-be-signed \$550bn Infrastructure Investment and Jobs Act in the US, which aims to reduce the cost of green H₂ from > \$5/kg today to < \$2/kg by 2026.
<https://www.rechargenews.com/energy-transition/hydrogen-now-firmly-at-the-heart-of-the-global-race-to-net-zero-for-better-or-worse/2-1-1058073>
- China approved a massive project to produce 66,900 tons of green H₂ from electrolysis of water using 1.85 GW of solar and 370 MW of wind electricity in the Inner Mongolia region. The project development starts in October and will be operational in mid-2023.

<https://www.bloomberg.com/news/articles/2021-08-18/china-approves-renewable-mega-project-focused-on-green-hydrogen>



- Toyota will be making fuel cell modules for Class 8 trucks at its Kentucky plant, which is currently the main source of the Camry sedan. The fuel cell system will deliver 160 kW of electricity, include the battery, motors and H₂ tanks, and > 300 miles of range at a full load weight of 80,000 lbs.

<https://www.forbes.com/sites/alanohnsman/2021/08/25/toyota-to-make-fuel-cell-modules-at-kentucky-plant-for-hydrogen-big-rigs/?sh=50d548f84e54>



- Alstom announced the world's first passenger train powered by H₂ fuel cells to be operational in Sweden. It can carry 300 passengers over a range of 1,000 kms and achieve top speeds of 140 km/h.

<https://www.alstom.com/press-releases-news/2021/8/alstoms-coradia-ilint-hydrogen-train-runs-first-time-sweden>



- Trucks, trains and – why not aircrafts? A project backed by the UK government is promising H₂ fuel cell powered aircrafts as early as 2024. A 600-kW fuel cell powertrain will propel a 19-seat aircraft with 500 nautical mile range.

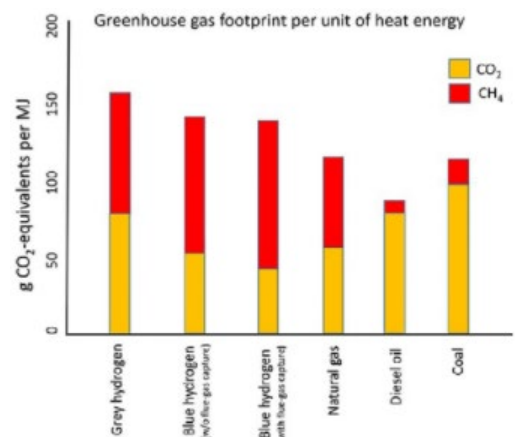
<https://www.h2-view.com/story/octopus-hydrogen-to-fuel-zero-emission-flights/>

- The first-of-its-kind coal-free delivery of steel made using green H₂ was made to Volvo. This was a trial run with industrial scale production slated by 2026.

<https://www.sciencealert.com/the-first-deliveries-of-green-steel-suggests-its-future-is-not-far-off>

- A publication from Cornell and Stanford university argues that blue hydrogen has no role to play in decarbonization. Blue H₂ is that produced via steam methane reforming (SMR) along with capture and sequestration of the CO₂ generated along the various steps. The authors considered the CO₂ and methane generation and abatement from (a) fuel delivery, associated with about 3.5% methane emissions, (b) energy for methane reforming, derived from burning natural gas, (c) CO₂ released from the methane reforming step to generate H₂, and (d) CO₂ capture from both reforming and energy supply. Total emissions for blue H₂ were only 9 – 12% lower compared to gray H₂ (that is using SMR without carbon capture) and worse than using natural gas, diesel or even coal for direct heating.

<https://onlinelibrary.wiley.com/doi/epdf/10.1002/ese3.956>

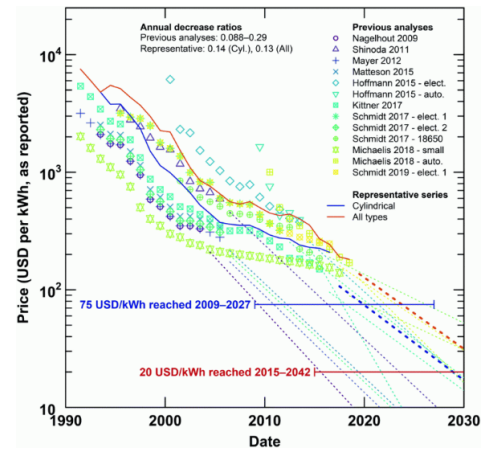


Battery electrics

- A publication from MIT explored the correlation of the decline in Li-ion battery prices with improved technology (Moore's Law), cumulative production (Wright's Law), annual production (Goddard's Law) and R&D activity as measured via patent filings. For price scaled by energy capacity, the analysis shows a learning rate of ~ 20 – 24%, with a higher rate for the cylindrical cells. That is, the price of battery cells per kWh of capacity has decreased by 24% (for cylindrical cells) with every doubling of the cumulative production. Read here for a summary and a link to the article –

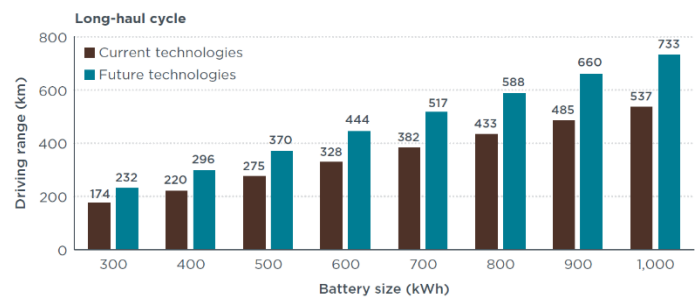
<https://mobilitynotes.com/a-good-review-of-lithium-ion-battery-cost-reductions/>

<https://pubs.rsc.org/en/content/articlelanding/2021/ee/d0ee02681f>



- The ICCT has done an analysis of the suitability of battery electric powertrain for heavy-duty trucks in Europe. The driving range was calculated over various drive cycles and with varying payloads, ambient temperatures, state-of-charge, and thermal management systems. A couple of key conclusions from the study are that for a 500 km driving range (covering most applications):

- A 1,000-kWh battery is needed today, but the size can reduce by 30% to 700 kWh by the end of the decade due to various improvements in batteries, vehicle weight, etc. and
- There is a 11% payload penalty due to battery weight today, but this will disappear also with the improvements in battery energy density and vehicle level improvements.



<https://theicct.org/publications/eu-tractor-trailers-analysis-aug21>

Don't miss these upcoming events ...

15th 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

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

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

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