

EVs Early Fall 2023

By John Benson

October 2023

1. Introduction

The prior EV paper was posted on September 12. It is described and linked below.

EVs Late-Summer 2023

Technology

What's next for Batteries?

GM Bets Big on Iron

Business

Tesla:

- *Tesla's Native Lands Partnerships*
- *Why Elon is Glad*
- *2024 Model 3*

LG Energy / Honda Venture

Subaru's New EV Strategy

New Nissan Vehicles

Nikola, Still Struggling and Focused on Hydrogen

<https://energycentral.com/c/ec/evs-late-summer-2023>

This EV Paper has the following content:

Technology:

- Trade-offs: Price vs. Range vs. Performance
- Are Chargers Keeping Pace with EV Expansion?

Business:

- Record Global EV Sales, Growth expected through 2023
- A \$3 Billion Truck Venture
- EVs Switch gets \$12 billion in loans & grants from DOE
- EX30, the Smallest, Least Expensive Volvo

2. Technology

This section becomes increasingly difficult to find new material for without diving into regulation or material previously covered. I decided to start out with the latter in this paper, but with a different (AI) spin.

2.1. Trade-offs: Price vs. Range vs. Performance

I covered the primary subject of this post, battery lifetime, in the post partially described and linked below:

EVs Mid-Summer 2023: *This paper covers the following subjects:*

Technology:

...Section 2.4, How Long Do Electric Car Batteries Last?

<https://energycentral.com/c/ec/evs-mid-summer-2023>

There are numerous strategies for maximizing battery lifetimes, and there is also a system that implements these strategies to make sure the lifetime (at least) meets warranty / regulatory requirements. After researching this subject over several days resulting in the above title, but little else, I finally found the magic question to invoke my sidekick: "Microsoft Bing's Generative AI companion (I expect this is ChatGPT by Microsoft affiliate OpenAI)".

Battery management systems (BMS) play a crucial role in ensuring the longevity of electric vehicle (EV) batteries. The BMS regulates the charging and discharging of the batteries, which helps to prolong their life¹. The BMS also monitors the battery's temperature, state of charge, and state of health to ensure that the battery is operating within safe limits.^{2 3}

The BMS is designed to prevent overcharging and over-discharging of the battery, which can damage the battery and reduce its lifespan.² The BMS also ensures that each cell in the battery pack is charged and discharged evenly, which helps to prevent capacity imbalances between cells⁴.

The BMS can also help to extend the life of an EV battery by reducing the impact of factors that can degrade battery performance over time. For example, the BMS can limit the battery's exposure to high temperatures, which can accelerate battery degradation¹. The BMS can also limit the depth of discharge of the battery, which can help to reduce the rate of capacity fade over time⁵.

In summary, a well-designed BMS is essential for ensuring the long-term health and performance of an EV battery. By regulating charging and discharging, monitoring temperature and state of charge, and preventing overcharging and over-discharging, a BMS can help to extend the life of an EV battery and ensure that it operates safely and reliably².

¹ EVConnect, "How Long Does an Electric Car Battery Last?" Nov 8 (2022?),

<https://www.evconnect.com/blog/how-long-does-an-electric-car-battery-last>

² A. Hariprasad, International Journal of Engineering Research & Technology (IJERT), May 25, 2020, "Battery Management System in Electric Vehicles," <https://www.ijert.org/battery-management-system-in-electric-vehicles>

³ Microsoft Bing Generative AI. Magic question is: "How do battery management systems in Electric Vehicles assure long battery lifetimes?" <https://www.bing.com/>

⁴ Analog Devices, ADI Signals+, "Longevity And the Battery Management System," <https://www.analog.com/en/signals/articles/longevity-battery-management-system.html>

⁵ MDPI, A. K. M. Ahasan Habib, et al, "Lithium-Ion Battery Management System for Electric Vehicles: Constraints, Challenges, and Recommendations," Jan 12, 2023, <https://www.mdpi.com/2313-0105/9/3/152>

Author's comment: I would guess that the battery management system (BMS) implementation is highly proprietary to a given vendor and/or implemented by a few leading vendors. In order to verify this, I asked Bing another magic question.⁶

The answer was reasonable, but this is where I needed to intervene and do some more research. The answer referenced two sources each with a list of “leading vendors.” The list for the first source had several red flags, so I eliminated these vendors. The list of vendors from the second source was shorter, but had one vendor⁴ I was familiar with so I decided to research the vendors from this source (most were reasonable). The firms that made it through this filter are summarized and the leading vendors are linked below:

Renesas Electronics Corporation: This Company is in the SF Bay Area (In Milpitas), I would assume a leading area for the target technology.⁷ Go through the link below for details, but I found that they made many products similar to the target BMS.

<https://www.renesas.com/us/en>

NXP Semiconductors: As the above company this is in the SF Bay Area (San Jose) and seemed to be focused on BMS and other smart automotive applications. Link is below.

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

Keihin Corporation: HQ is in Japan, but they have a reasonable separate North American Site (linked below). They seem to be focused on a wide range of automotive products rather than smart systems. Note that the message at the top of their home page reads: “Keihin North America is now Hitachi Astemo Indiana!” I decided not to go down that rabbit hole.

<https://www.keihin-na.com/>

TE Connectivity: In SF Bay Area (Fremont), but very broadly focused. I’m not going to provide a link, but you can look it up on your search engine of choice.

Analog Devices, Inc.: This is the large company that I’ve heard of before. However, like the above company, they are very broad based, and “automotive” is not on a rather long list” of applications. See reference 4 above for more information in this company’s BMS. They are in the SF Bay Area (Milpitas).

I would guess that most of the above companies would be reasonable candidate partners to help an EV manufacturer develop a BMS.

2.2. Other Ways to Extend Batteries’ Lifetimes

These are basically my own thoughts on this.

2.2.1. Battery Management System

I would guess that all significant EV brands have a BMS, but there are questions about this system, specifically:

1. How many EVs has a vendor shipped with a particular BMS?

⁶ Microsoft Bing Generative AI, Magic question is: “What are leading vendors for Electric Vehicle battery management systems?” <https://www.bing.com/>

⁷ The SF Bay Area was the original home of Tesla around Y2K, and is a leading center for software development.

2. How much owner tuning to the BMS is accessible through the user interface?
3. If the answer to 2 is some, how many adjustable parameters significantly impact battery lifetime?
4. How open is a particular EV Manufacturer about the details of their BMS?

Let's start with 1. Good luck on getting much information on this, so some assumptions need to be made. If a perspective vendor has only shipped hundreds to single-digit thousands of EVs, you can probably assume they are BMS novices. If they have shipped high hundreds of thousands to millions (like Tesla and Nissan), you can probably assume they are experts. Furthermore, even though Tesla moved their HQ to Texas, they kept their engineering center in the SF Bay Area. Ditto their most productive factory (The Fremont "Mothership").

Question 2 and 3: Some questions might extract this information. Like for instance:

- If an owner makes frequent use of the EVs maximum acceleration, can this be overridden by the BMS Thermal Management function?
- Can the limits be adjusted by the owner?"
- Can the BMS thermal management adjust the regenerative braking level?
- Can the BMS thermal management adjust the cabin-cooling level or conversely does a temporary need for extra battery-cooling impact the available cabin-cooling.
- Does the cabin heating use a heat pump or resistive heating. In either case, does it use the same energy source (see next question) as the battery heating system?
- Does the battery heating system use energy coming through the charger to keep the batteries warm when the EV is unoccupied and charging? Also, can this system preheat the cabin (& batteries) before departure using charger energy?

2.2.2. Federal & State Requirements for EV Battery Warranties

I asked my sidekick to answer this question again, and it came up with a reasonable answer, so I will repeat it below.

The US federal government mandates that automakers provide electric vehicle (EV) battery warranty coverage that lasts at least eight years or 100,000 miles. However, California State government has boosted this to 10 years or until 150,000 miles^{8 9 10}.

It's worth noting that most automakers have an 8 to 10-year or 100,000 miles warranty period on EV batteries.¹¹

⁸ Microsoft Bing Generative AI, magic question is: "What are US federal and any state requirements for an electric vehicle battery warranty?" <https://www.bing.com/>

⁹ Elizabeth Linehan, Louisiana Clean Fuels, "Electric Vehicle Batteries: Warranties and Lifetimes" Aug 6, 2022, <https://louisianacleanfuels.org/blog/id/541>

¹⁰ Warren Clarke, U.S. News, "Car Warranty Coverage on an Electric Car Battery," Feb 15, 2023, <https://cars.usnews.com/cars-trucks/advice/ev-battery-warranty>

¹¹ Dave Nichols, Green Cars, "EV Battery Warranties and Exclusions," June, 2023, <https://www.greencars.com/greencars-101/ev-battery-warranties-and-exclusions>

The EV battery warranty covers the replacement cost if the battery fails to perform as it should. Manufacturers offer this protection over a stated period or mileage limit. For example, Tesla's electric car battery warranty on the Model S lasts 8 years or 150,000 miles, whichever comes first...

2.3. Are Chargers Keeping Pace with EV Expansion?

The second subject on the minds of potential EV Owners and Buyers is the title of this subsection. The short answer is: yes, and then some. But in the future you may want to follow the news yourself, so most of this subsection will educate readers about the expansion pathways.

2.3.1. Standards and Crossovers

The big charger news lately is that Tesla is opening its charger network to other EV maker's vehicles. This is mainly because the Tesla network is largest and most advanced by several metrics.

The Tesla charging standard is called the North American Charging Standard (NACS), which is an electric vehicle (EV) charging connector system developed by Tesla, Inc. NACS has been used on all North American market Tesla vehicles since 2012 and was opened for use to other manufacturers in 2022.

The NACS connector is the most common charging standard in North America, with NACS vehicles outnumbering CCS two-to-one, and Tesla's Supercharging network having 60% more NACS posts than all the CCS-equipped networks combined. The NACS connector offers AC charging and up to 1 MW DC charging in one slim package, and it has no moving parts, is half the size, and twice as powerful as Combined Charging System (CCS) connectors. Network operators already have plans in motion to incorporate NACS at their chargers, so Tesla owners can look forward to charging at other networks without adapters.¹²

The Combined Charging System (CCS) is a standard for charging electric vehicles. It is the most common electric vehicle fast-charging standard and can provide power at up to 350 kilowatts (kW). The CCS connector can use Combo 1 (CCS1) or Combo 2 (CCS2) connectors to provide power. It is popular across Europe and North America for a quick charge and offers a higher power rating than other rapid types 2. The CCS plug is a fancied-up version of the Type 2 plug that is universal for charging EVs.¹³

Since Tesla has and is slowly opened their network over time (and this is still in progress), the CCS was originally viewed as "open standard" and Tesla's NACS network as a proprietary standard (although Tesla's network has always been more advanced and the largest in the US since 2012). However recently many EV manufacturers are migrating to NACS for their future cars.

EV adoption has been chaotic, to say the least. There are different battery types, chemical compositions, charge rates and mileage, and variations of a bunch of other parts across manufacturers. But one of the biggest issues in differences between EVs of this new era is physically charging the car itself.¹⁴

¹² Microsoft Bing Generative AI, magic question is: "What is the tesla EV charging standard?"
<https://www.bing.com/>

¹³ Microsoft Bing Generative AI, magic question is: "CCS EV Charging Standard?"

¹⁴ Jonathon Klein, The Drive, "Here's Every Automaker Switching to Tesla's NACS EV Charging System (Updated), Updated Sep 7, 2023, <https://www.thedrive.com/guides-and-gear/which-cars-nacs-charge-plugs>

Automotive manufacturers have experimented with a host of plug styles—including Nissan's not-so-great CHAdeMO charger—but the plug types have now been whittled down to Tesla's North American Charging Standard (NACS) and a more broadly adopted Combined Charging System (CCS). Yet, that too is now changing.

After the last few years of early adopters suffering at the hands of a non-regulated landscape of CCS public chargers that don't work or fail to operate properly, and listening to those customers' complaints, automakers are now switching to Tesla's NACS standard. Why? Well, because Tesla's more ubiquitous Supercharger network actually works more often than not and it spans most main corridors in the United States and abroad.

NACS Users

Tesla: Obviously, Tesla isn't going to switch to CCS now that everyone else is switching to NACS. Plus, the company developed the technology and it will continue using NACS.

Ford was the first automaker to make the switch from CCS to NACS. According to Ford, the Blue Oval will fully adopt the NACS plug for all of its EVs by 2025, with an adapter available to older EV chargers soon.

General Motors (GM) will also adopt the NACS standard, and follow Ford's lead by switching the physical plug in all of its new EVs by 2025. The company also stated a plug adapter will become available by Spring 2024.

Rivian was an odd one to adopt NACS, as other EV automakers tend to want to stick with the CCS option for a variety of reasons. However, given Rivian's teething problems, it does make sense that the company wants to reduce as much customer strife as possible to entice new ones.

Volvo is the latest automaker to adopt the NACS plug, though it's unclear whether or not its other Geely-backed brethren will also choose NACS. It will adopt NACS by 2025.

Volvo's cousin, **Polestar**, has also stated that it will adopt NACS by 2025.

As of July 7th, **Mercedes-Benz** stated that it too will make the switch to Tesla's NACS charger. According to the German brand, it will have Tesla Supercharger access starting in 2024 before adopting the NACS plug in all of its EVs by 2025.

Nissan: According to a July 2023 announcement, Nissan will begin offering EVs for the U.S. and Canadian markets with a NACS port starting in 2025. "From 2024, Nissan will make available a NACS charging adapter for Ariya models which are currently equipped with the Combined Charging System 1 (CCS1) for DC fast charging. This will enable customers to connect their vehicle's charging port to NACS plugs at compatible chargers," the automaker stated in a press release.

Honda: As of September 7, 2023, Honda stated that not only will it be adopting NACS, but that "In 2025, Honda is planning to launch a new EV model in North America equipped with a NACS port. From that point forward, Honda will continue adopting NACS standards for its models."

It's also noteworthy that Honda joined a number of other automakers in coming together to produce and distribute more fast-charging stations across the United States (see subsection 2.3.3).

See the reference here for the latest list that I have seen.¹⁵

2.3.2. The Tesla Experience?

First of all, I'm not an EV Owner, but I've worked on human-machine interfaces most of my career, and believe that I know how Tesla's supercharging network works. That is, when you plug a Tesla into a Supercharger, the system identifies that car, and confirms that it has a valid account associated with it. If these criteria are met, you start charging. Although non-Tesla EVs might be able to plug in, there is the parallel financial transaction that needs to occur, and I don't believe that it will be there, at least not initially.

To test the above I asked my sidekick (Microsoft Bing Generative AI) the following question: "Tesla EVs use the supercharger network, and (if they have a Tesla Account) have a plug-and-charge experience. As non-tesla EVs start using NACS how much of this same experience will they have?" It's answer follows.

Non-Tesla electric vehicle (EV) owners will likely have a different charging experience compared to Tesla EV owners. Tesla's Supercharger network is widely regarded as superior to the public charging network in the United States...

However, I believe it is Tesla's best interest to allow non-Tesla EV Owners to evolve to a similar experience as Tesla Owners. The Tesla NACS adoption by most major auto makers is an opportunity for the Tesla Supercharger Network to become (by far) the dominant light EV Charging network in the free world. This represents a huge incremental business opportunity for Tesla.

2.3.3. 7 auto giants build network of 30K+ fast chargers

And yes, it'll have NACS accessibility. In a shocking but exciting announcement this morning, a group of some of the world's largest automakers has combined forces into a new joint venture to deliver a new "high-powered" charger network across cities and highways in North America to expedite EV adoption. Oh, and they intend to power the entire network with renewable energy.¹⁶

This is big news.

In covering this beat, we've seen EV adoption and innovation, as a whole, absolutely snowball globally in recent years. In North America, the transition to EVs by legacy automakers and consumers alike has been expedited by advantageous legislation implemented by US and Canadian governments.

In the US, the Biden administration's Build Back Better Plan and passed Inflation Reduction Act have established federal tax credits for new and used EV leases and purchases, while helping fund the National Electric Vehicle Infrastructure (NEVI) program to enable the installation of EV charging stations around the country.

The past two years especially, we've seen young and legacy EV automakers alike pairing up with existing charging networks that are slowly but surely expanding availability – permitting, grid access, and maintenance woes be damned.

¹⁵ Emily Dreibelbis, PC Magazine, "Here Are the EVs That Can Charge at Tesla Superchargers Starting in 2024," Sep 21, 2023, <https://www.pcmag.com/news/electric-vehicles-that-can-charge-at-tesla-superchargers> Note that this is a comprehensive list, but prefaced by a long article.

¹⁶ Scooter Doll, Electrek, "7 auto giants unite to build universal network of 30K+ clean-energy-powered fast chargers to North America," Jul 26 2023, <https://electrek.co/2023/07/26/auto-giants-unite-build-universal-network-clean-energy-fast-charger-north-america/>

Despite all that, Tesla's Supercharger network has remained the undisputed champion in fast charger access and dependability, especially now that universal Magic Dock piles are rolling out, offering charging access to other branded EVs.

While our recent focus has been on nearly all major automakers and charging networks adopting Tesla's North American Charging Standard (NACS), it appears to be a mere footnote in today's story that could see the number of publicly available DC fast chargers nearly double in a short time.

So who's behind this massive joint venture to deliver a clean-powered charger network? You'll recognize every single name.

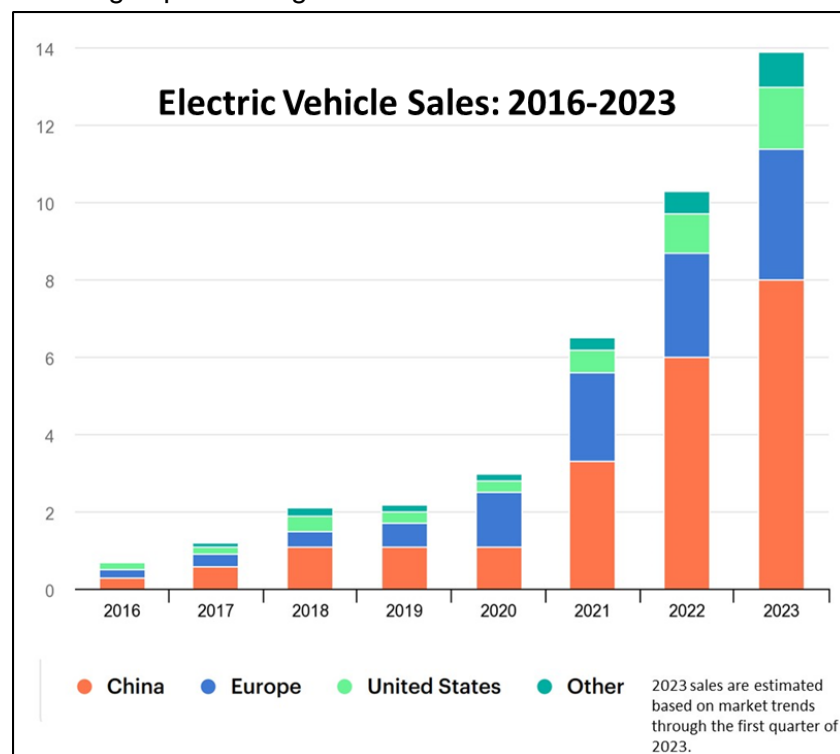


3. Business

3.1. Record Global EV Sales, Growth expected through 2023

Global EV Markets are seeing exponential growth as sales exceeded 10 Million in 2022.

Sales has more than tripled in three years from around 4% in 2020 to 14% in 2022. This growth is expected to continue in 2023 (see chart right).¹⁷



¹⁷ International Energy Agency (IEA), "Electric Vehicles," <https://www.iea.org/energy-system/transport/electric-vehicles>

3.2. A \$3 Billion Truck Venture

Cummins, Daimler and Paccar, three of the trucking industry's biggest players, are forming a multibillion-dollar joint venture to produce battery cells for commercial vehicles and other industrial applications at a U.S. plant, the biggest such project of its type in North America.¹⁸

The companies plan to invest as much as \$3 billion combined and each hold 30% stakes in the as-yet-unnamed venture, which will open in a little over three years. It will be scaled to churn out 21 gigawatt-hours of lithium-iron-phosphate, or LFP, battery cells annually at a factory site that hasn't yet been determined, Cummins CEO and President Jennifer Rumsey told Forbes. Chinese battery maker EVE Energy will share its LFP cell technology with the venture and own a 10% stake.

Cummins, a diesel engine giant that's expanding into cleantech, and the two truck-makers are sharing "this significant investment as our industry starts to transition to ensure we have cost-competitive, performance-leading cells we each can then use in battery packs we'll be manufacturing independently," Rumsey said. Many battery plants are in the works for electric cars, but "I'm not aware of any other battery project here in the U.S. or North America focused on commercial vehicle and industrial applications," she said.

The project arrives on the heels of Cummins launching Accelera, its cleantech unit, to compete in a growing market for battery-electric and hydrogen-fueled trucks. It also coincides with makers of trucks and buses, just like automakers, being pushed to shift to electric power to curb planet-warming CO₂ emissions. California, the biggest auto market in the U.S., recently created rules requiring all medium- and heavy-duty trucks operating there to be zero-emission by 2045,¹⁹ a move about a dozen other states may follow. Meanwhile, the federal government is offering new incentives for manufacturers to build domestic battery and component plants that the partners should be able to tap.

Rumsey says that the venture's decision to use LFP, rather than lithium-ion cells typically used in electric vehicles, was driven by its relatively lower cost. Though it's less energy-dense than lithium-ion and a bit heavier, LFP doesn't use pricey nickel or cobalt and may prove to be more durable over time.

¹⁸ Alan Ohnsman, Forbes, "A \$3 Billion Monster Truck Venture to Electrify Commercial Vehicles," Sep 6, 2023, <https://www.forbes.com/sites/alanohnsman/2023/09/06/a-3-billion-monster-truck-venture-to-electrify-commercial-vehicles/?sh=6f3f6ded19c9>

¹⁹ Under the new rule, fleet owners operating vehicles for private services such as last-mile delivery and federal fleets such as the Postal Service, along with state and local government fleets, will begin their transition toward zero-emission vehicles starting in 2024. The rule includes the ability to continue operating existing vehicles through their useful life. Due to the impact that truck traffic has on residents living near heavily trafficked corridors, drayage trucks will need to be zero-emissions by 2035. All other fleet owners will have the option to transition a percentage of their vehicles to meet expected zero-emission milestones, which gives owners the flexibility to continue operating combustion -powered vehicles as needed during the move toward cleaner technology. The flexibility is intended to take into consideration the available technology and the need to target the highest-polluting vehicles. For example, last mile delivery and yard trucks must transition by 2035, work trucks and day cab tractors must be zero-emission by 2039, and sleeper cab tractors and specialty vehicles must be zero-emission by 2042. <https://ww2.arb.ca.gov/news/california-approves-groundbreaking-regulation-accelerates-deployment-heavy-duty-zevs-protect>

The Cummins-Daimler-Paccar joint venture could be delayed getting off the ground because one of the partners, EVE, is a China-based company. The Committee on Foreign Investment in the United States, or CFIUS, will review the deal to ensure there are no problems with EVE's participation, the companies said in an emailed statement.

"For this LFP chemistry, EVE really has a leading solution and the technology manufacturing know-how," Rumsey told Forbes. "This is about creating a plant here in the U.S., building a supply chain and U.S. jobs."

Nearly every other major new North American battery plant announced over the past year is focused on lithium-ion cells, though Ford is investing \$3.5 billion for a new factory in Michigan that will make both LFP cells and nickel cobalt manganese lithium-ion batteries. That project also relies on LFP tech from a Chinese partner, Contemporary Amperex Technology Limited, or CATL, the world's top battery maker.

Each partner will decide how to use cells in their products. Cummins' Accelera may focus on using them in buses and medium-duty vehicles as well as stationary energy storage systems, Rumsey said. Daimler, maker of Freightliner, Mercedes-Benz and Fuso brands, and Paccar, which builds Kenworth and Peterbilt semis, will use them for trucks.

In terms of scale, the new plant's 21-gWh output would create the materials for enough batteries to power 80,000 medium-duty trucks a year or up to 40,000 electric buses, Rumsey said.

3.3. EVs Switch gets \$12 billion in loans & grants from DOE

The US Department of Energy said Thursday it plans to fuel the auto industry's transition to electric vehicles with \$12 billion in loans and grants.²⁰

Hard on the heels of President Joe Biden's goal to spur the sale of EVs in the United States, the Energy Department will provide \$2 billion in grants and \$10 billion in loans to support the conversion of US automaker and supplier facilities into manufacturing centers for hybrid and electric vehicles.

The program aims to build or refurbish factories in communities with existing auto manufacturing facilities and to bolster the domestic EV supply chain.

The funding pledge comes after the Biden administration announced earlier this year an ambitious policy proposal that could require electric vehicles to account for two-thirds of new cars sold in the United States by 2032. The Biden administration previously directed the US federal government to get to net zero carbon emissions by 2050...

The Energy Department also said it plans to invest a separate \$3.5 billion to boost US production of advanced batteries and battery materials to support the country's transition to electric vehicles and clean energy.

The move comes as Biden tries to win over the powerful United Auto Workers union, which has thus far withheld its endorsement of his reelection bid over concerns about policies that would encourage a transition to electric vehicles.

²⁰ Clare Duffy, CNN, "Auto industry's switch to EVs gets \$12 billion in loans and grants from the US Energy Department," Aug 31, 2023, <https://www.cnn.com/2023/08/31/cars/biden-evs-usde-billion-manufacturing/index.html>

"We are glad to see the Biden Administration doing its part to reject the false choice between a good job and a green job," said UAW President Shawn Fain in a statement. "This new policy makes clear to employers that the EV transition must include strong union partnerships with the high pay and safety standards that generations of UAW members have fought for and won."

Transportation is the biggest source of planet-warming pollution in the US, the Congressional Budget Office said in a December report. It also noted that light duty vehicles, the average cars Americans drive, account for 58% of those emissions.

3.4. EX30, the Smallest, Least Expensive Volvo



Expanding its EV offerings, Volvo is launching the small EX30 SUV with chic styling to go along with its expected high-tech platform. Single- and Dual-Motor versions are available, the former with a 268-hp rear-wheel-drive setup and the latter with a 422-hp all-wheel-drive arrangement that Volvo says makes the EX30 its quickest-accelerating vehicle to date. No matter which powertrain you choose, you'll get the same 64.0-kWh battery pack that is said to offer up to 275 miles of driving per charge...²¹

The good news is that the EX30's base price is \$36,145, and Volvo is accepting pre-orders currently. The bad news is that Volvo is currently only made in China, and thus would not be eligible for an IRA tax rebate unless Volvo moves production (including batteries) to the U.S. But perhaps there is further good news.

Volvo's South Carolina-based car factory is in for an electric makeover. According to a report and interview with various executives from Automotive News Monday, the plant will transition to build solely electric vehicles. With the switch, Volvo plans to embrace a "build where you sell" mentality, according to the report, as it gears up to make the plant a hub for US EV production.²²

²¹ Drew Dorian, Car and Driver, "2025 Volvo EX30," <https://www.caranddriver.com/volvo/ex30>

²² Sean Szymkowski, CNET, "Volvo's South Carolina factory will exclusively build electric cars," June 28, 2021, <https://www.cnet.com/roadshow/news/volvos-south-carolina-factory-will-exclusively-build-electric-cars/>