

EVs Early Spring, 2023

By John Benson

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1. Introduction

My last post in this series is summarized and linked below:

EVs Late Winter, 2023 was in mid-March and covered the following subjects:

Supply Chain:

- *GM and Ford are making major commitments to assure Lilon Battery supply.*
- *Redwood Materials has won a major US Federal Grant to expand its production.*

Rental EVs and New EVs:

- *EVs from major rental car firms*
- *We will review a future EV (2024) from Honda that is below \$50k*
- *There is an upcoming commercial vehicle from Mercedes.*
- *Five Reasons an Electric Vehicle Saves You Money*

Manufacturer's Strategy:

- *Toyota EV Strategy evolves.*
- *VW's sub-\$25K EV*

Tesla:

- *Additional information on the Tesla Semi.*
- *Major Lithium Move?*
- *They're ba-a-ack.*
- *Investor Day announcements.*
- *Price Reductions for Model S and Model X*

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

This post will cover the following subjects:

Supply Chain:

- Tesla borrows a strategy from Ford

New emerging business model for EV charging networks:

- Groceries and a Quick-Charge
- 7-Eleven

Green Truckin' – Mr. Farley: what is required to make a really green truck?

EV Hosting Futures:

- PNNL report: the impact of EVs on the grid in the future
- Tesla V4 Supercharger – More Power & CCS

Upcoming EVs:

- VW's Scout and ID Buzz

EV's in Alaska?

Highest Performance EV Batteries

Tesla's Q1 Results

2. Supply Chain

2.1. Tesla Borrows a Strategy from Ford

In the last issue of this post (see the Intro) we reviewed a new major Michigan Battery Plant that Ford is building that will use technology Licensed from Contemporary Amperex Technology Co. Ltd (CATL). Ford's Plant will probably use CATL's new M3P Battery. Ditto Tesla's new plant described below. See my added comments near the end of section 4 for more details.

*Tesla Inc. is looking to build a battery plant in the US, according to people familiar with the matter, in what would likely be a controversial arrangement with CATL, China's dominant electric-vehicle battery manufacturer.*¹

The EV maker discussed plans involving CATL with the White House in recent days, said the people, who asked not to be identified revealing private conversations. Tesla representatives sought clarity on the Inflation Reduction Act rules that the Biden administration is finalizing this week, according to some of the people. Rohan Patel, the company's senior global director of public policy, was among those involved with the discussions, one of the people said.

Tesla wants to pursue a deal similar to one that Ford Motor Co. announced last month in Michigan with CATL, to construct a plant wholly owned by the US automaker,.

Representatives of Tesla, CATL and the White House didn't immediately respond to requests for comment. Patel also didn't respond...

Tesla is in expansion mode, deploying its \$22 billion in cash to crank up production volumes and lower costs as it faces increased competition. CATL, which makes lithium iron phosphate batteries (in addition to their new MP3), a chemistry that is cheaper than the nickel-based batteries used in the West, is key to that plan.

The automaker is considering building the battery plant in Texas to supply its EV assembly plant there, though a location hasn't been finalized, some of the people said. Like the Ford deal structure, Tesla would own and operate the factory while licensing the technology from CATL.

The auto industry has been lobbying to influence how the US Treasury Department will interpret requirements in President Joe Biden's signature climate package. The law is intended to wean the US off its dependence on China for battery materials by incentivizing a US-based supply chain for EVs. One clause that has been the object of intense lobbying is designed to withhold consumer tax credits for EVs made with a certain amount of China-linked materials in their batteries...

Tesla uses CATL LFP Batteries in EVs it builds in China, and perhaps other locations.

¹ BatteriesNews, "Tesla Pursues Building a New US Battery Plant With CATL, China Dominant Battery Maker," March 30, 2023, <https://batteriesnews.com/tesla-pursues-building-new-us-battery-plant-catl-china-dominant-battery-maker/#>

In June 2021, Tesla and CATL had signed a new supply agreement for battery cells that runs from January 2022 to December 2025. No details on the agreed-upon supply volume or cell chemistry were provided at the time. Then in October, there was a report that Tesla had ordered 45 GWh of LFP cells from CATL for 2022 alone. Based on the size of the LFP batteries in current Tesla models that should be enough for about 800,000 vehicles. Since Giga Shanghai is currently designed for 450,000+ vehicles, some cells should also be installed in other Tesla plants.²

3. New Business Model for EV Charging Networks

Optimally siting public charging stations is mostly about the affinity between EV-owners normal shopping habits and the time required to quick-charge their EVs.

3.1. Groceries and a Quick-Charge

Near our primary residence (Livermore), we have a small Lucky supermarket in the small Granada Shopping Center. Lucky Stores, Inc. is a subsidiary of American Stores Company, which is in turn a division of Albertson's. They have stores in most major metro-areas in California.

About a year ago, I noted that some major construction project was being built in front of Lucky. This ended up being a small (6 chargers) Electrify America Charging Station.

The chargers ended up being 5 of the 150 kW CCS “Ultra-Fast” chargers and a single CHAdeMO 50 kW charger. These are all within about 50 ft. of the front entrance to Lucky. Since they were commissioned, I’ve noted that the at least one or two of these chargers are frequently charging EVs, and during morning and evening “rush-hours” frequently three or four are charging. Even if you don’t own an EV ask yourself how often do you stop by a neighborhood grocery store on the way to or from work?

Also, one of the big advantages of EVs is their ability to charge overnight, IF you have a garage or driveway with a nearby charger. One of the biggest complaints is from EV-drivers that don’t have this convenience.

Considering the above, I wasn’t surprised when I saw the article excerpted for the subsection below.

3.2. 7-Eleven

7-Eleven is one of the most popular convenience store chains in the U.S. and Canada.

7-Eleven, Inc. is the premier name in the convenience-retailing industry. Based in Irving, Texas, 7-Eleven operates, franchises and/or licenses more than 13,000 stores in the U.S. and Canada.³

7-Eleven this month launched an electric-vehicle charging network in the US, joining a growing number of nationwide retailers with EV chargers.⁴

² Electrive.com, “CATL delivers first LFP cells to Tesla Giga Shanghai,” Jan 8, 2022, <https://www.electrive.com/2022/01/08/catl-delivers-first-lfp-cells-to-tesla-giga-shanghai/>

³ https://corp.7-eleven.com/corp/about?utm_source=7-eleven.com&utm_medium=referral&utm_campaign=corpcom_2021

⁴ Dan Avery, CNET, “7-Eleven Launches 7Charge Electric Vehicle Charging Network,” March 23, 2023, <https://www.cnet.com/roadshow/news/7-eleven-launches-7charge-electric-vehicle-charging-network/>

7Charge stations are now operational at select 7-Elevens in California, Colorado, Florida and Texas, with plans to add more in the US and Canada.

"Once the network's expansion is complete, 7-Eleven will have one of the largest and most compatible fast-charging networks of any retailer in North America," the company said in a statement. "7-Eleven will have the ability to grow its network to match consumer demand and make EV charging available to neighborhoods that have, until now, lacked access."

Drivers can find a nearby location and pay via the 7Charge app. According to 7-Eleven, pricing is based on either energy consumed or time spent charging, depending on the laws of the state.

Any make and model of EV with a CHAdeMO or Combined Charging System plug type and an adapter can use the 7Charge network. The system uses high-voltage DC plugs, which allow most cars to reach an 80% charge in roughly 30 minutes.

In 2021, 7-Eleven announced plans to add 500 EV ports at 250 locations in North America by the end of 2022, although it's not clear how many are currently in operation. 7-Eleven did not immediately respond to a request for comment.

President Joe Biden has made expanding US EV charging networks a priority, allocating \$7.5 billion toward building 500,000 more public chargers by 2030.

Other major US chains that have added EV charging stations include Ikea, Kroger, Macy's, Sears, Taco Bell, Walmart and Whole Foods. Walgreens has EV charging stations at approximately 400 locations, making it the largest retail host in the US...

Note that the above list includes many shopping and eating outlets. I would guess that 7-Eleven is both of those. Think of how often you have stopped at a convenience store to get a snack and your beverage-of-choice. Getting a quick-charge will give you time to consume these, which is safer than trying to eat and drive at the same time.

4. Green Truckin'

Most that know anything about EVs also know that Tesla et al are constructing factories to build EVs and their components as fast as they can. Especially considering recent U.S. tax policy changes. Also, for any product (like EVs) you need to look at the full life-cycle greenhouse gas emissions to know how effective a cure for climate change it is. The CEO mentioned in the third paragraph below knows this.

Ford CEO Jim Farley unveiled the company plans to reduce those emissions, including its new green manufacturing plant and the plant's first vehicle, an electric truck. Farley joined "GMA3" to discuss the plans and what they mean for the future of manufacturing.⁵

DEMARCO MORGAN: Can you tell us about the BlueOval City plant behind you and how it's a game changer in your eyes?

⁵ ABC News via MSN, "A game changer": Ford CEO touts new electric vehicle plant," March 24, 2023, <https://www.msn.com/en-us/autos/news/a-game-changer-ford-ceo-touts-new-electric-vehicle-plant/ar-AA193oU1>

JIM FARLEY: It's a game changer for us. And good afternoon to you. Game changer for us, because we're really starting to scale EVs. We're number two in the U.S., and with this plant, we're adding not only 6,000 American jobs, but, you know, hundreds and hundreds of thousands of capacity and the plant will be completely green. All the electrons that power the plant will be green electricity. So it's not just a story about an electric vehicle. It's actually a much bigger story about modernizing and decarbonizing our American manufacturing industrial system.

EVA PILGRIM: And today, Ford's announcing the first vehicle to be built at that plant you're at today, an electric vehicle codenamed Project T3. It's a truck. What are we going to see that we haven't seen yet in other EVs? And when will it roll out?

FARLEY: Well, you know, our Lightning is the best-selling electric pickup in the U.S., but this will be its successor and it will be fully software updatable. So over the air we'll be able to change and improve the truck every day for our customers. And we think it'll be the first technology we're going to land where on a sunny day in the highway, you'll be able to go to sleep in your Ford truck. So we don't have autonomous features for commuters where you're going to get the most precious thing in your life back, time.

MORGAN: And Jim, it is no secret that Ford has clearly embraced the electrical vehicle market as have others, and yet EVs have faced their share of problems. About 18 Ford F-150 Lightnings had to be recalled for a battery fire issue earlier this year. There have been Tesla battery fires, GM, BMW, Volvo, all had recalls due to EV fire risks. How can you assure people that your EVs are safe?

FARLEY: I'm so proud of the Lightning team. They stopped production. We stopped the battery production. We did everything we needed to do. We found that fire. It happened at Ford, not in customer's hands. We did exactly the right thing. Unlike other brands, we stopped the production. None of them got out in customer's hands. And that's exactly what we have to do to build a trusted brand on EV. We're also going to diverse battery chemistry with less risk, like the LMP battery plant we're building in Michigan.

Author's comment: Note the "...LMP battery Plant we're building in Michigan..." in the above paragraph. This was a new one on me. I researched it a bit, and found this LMP stands for "Lithium Mixed-Metal Phosphate." Note that "LFP" stands for Lithium Ferro (iron) –Phosphate. LFP is one of the most popular chemistries for lithium-ion batteries. I believe that LMP might also be known as the M3P Battery from CATL, who is Ford's partner in this Plant, and Tesla's proposed Texas Plant (see section 2.1 above).

...CATL has not released detailed technical information on M3P, we know that this battery will theoretically be about 15-20% higher in energy density than lithium iron phosphate battery... At the same time, M3P will also have the advantages of high safety and long life of lithium iron phosphate batteries. However, in terms of manufacturing cost, M3P is likely to be higher than traditional lithium iron phosphate batteries.⁶

⁶ INEWS, "Tesla's 'feeling goodbye', 'M3P battery will become the terminator of lithium iron phosphate battery?'" April 19, 2023, <https://inf.news/ne/auto/36abb986d58ecf5fbd72abbaed7881b8.html>

Back to the GMA3 Interview.

PILGRIM: We have to talk about money. EVs are expensive, more expensive than traditional cars. So if this is supposed to be better for our planet, how do you make these vehicles affordable so everyone who wants one can actually have one?

FARLEY: Yeah, great question. And that's a big part of Ford, obviously. You know, we democratized affordable vehicles, so that's a big part of our DNA. I think the first part is we have to design the vehicle differently to be a lot simpler. We have to scale to hundreds of thousands from tens of thousands. Like today, we're going to have a more efficient distribution without inventory like we have today with our dealers. And we're going to have to build it with less labor content. So we have to change everything...

5. EV Hosting Futures

I found an excellent report that evaluated the impact of EVs on the grid in the future. Also some details on Tesla Supercharger V4 are at the end of this section.

5.1. PNNL Report

...To better understand the growth in EVs, the Department of Energy (DOE) asked Pacific Northwest National Laboratory (PNNL) to perform an authoritative study of the impacts of EVs at scale on the electric grid.⁷

Phase I focused on impacts on the electric transmission systems. I would expect that EVs in neighborhood like mine will initially impact distribution systems.

Phase II work addresses key questions of interest to DOE related to the impacts of EV in the distribution systems:

- 1. When, where, and how many EVs will be adopted and how will they be charged?*
- 2. Given some prospective answers to the above question, what would be the EV hosting capability of a distribution system circuit?*
- 3. How could the hosting capability be expanded to accommodate more EVs and what would be the potential measures and cost*

This report documents the methodologies developed as part of this project and provides EV adoption modeling examples using distribution system circuit data provided by industry partner Southern California Edison (SCE).

5.1.1. Report Methods and Outputs

High-spatial Resolution EV Adoption Modeling: *This project established a new EV adoption modeling (EVAM) methodology for estimating the likelihood of EV adoption at the household level (unique street addresses).*

⁷ M. Kintner-Meyer, S. Sridhar, C. Holland, A. Singhal, K. Wolf, Curtis Larimer, Casey McGrath, Amelia Bleeker and Rani Mural, Pacific Northwest National Lab (PNNL), “Electric Vehicles at Scale – Phase II Distribution System Analysis,” March 2022, https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-32460.pdf

The model is fitted with California's Department of Licensing registration data and socio-economic inputs such as household income, assessed home value, and access to EV charging infrastructure. This model estimates the likelihood of EVs to be charged within neighborhoods.

The spatial results of projected EVs are then passed on to a power flow simulation capability to estimate potential power flow violations of the distribution system at the circuit level.

Development of Tools for Estimating EV Hosting Capabilities: *We developed a methodology and programming scripts for estimating EV hosting capabilities for distribution system planning...*

Testing Development Tools for an SCE Distribution Feeder: *In collaboration with SCE, we tested these methods and tools on a single distribution system circuit selected by SCE engineers. The distribution circuit provided electric services to 2,381 customers. The report concludes with a brief outline of next steps to implement the methodology into a user-friendly tool for distribution system planners...*

5.1.2. Major Findings

1. *The EVAM estimated probability of EV adoption by addresses within neighborhoods associated with the selected SCE test feeder. We identified high sensitivity to vehicle price and income. The model was formulated for three EV categories that varied by driving range capability. We estimated EV adoption with and without specific incentives, such as federal versus additional utility incentives. The model was calibrated to SCE's target of EV making up 76% of the light-duty vehicle stock by 2040. For the calibration, all state and federal incentives were applied throughout the forecasting horizon.*
2. *Given projections of EV adoption, the GridLAB-D results for the selected SCE distribution feeder (Mallet) indicated no operational challenges until 2025. After 2025, because of the cumulative EV load growth, we identified some overloading of secondary transformers. Overloading conditions will increase with continuing EV growth unless mitigation strategies were applied.*
3. *The modeling results allowed the distribution system planner to identify the specific secondary transformers that need to be upgraded to avoid voltage violations and exceedance of rated capacities. Given the specific distribution circuit topology, we identified specific locations highly prone to overloading.*
4. *We explored two mitigation strategies: (1) infrastructure upgrading and (2) smart charge management as a demand management strategy.*
 - a. **Infrastructure upgrading:** *Two investment strategies were explored: aggressive and conservative. Adopting an aggressive strategy would result in upgrading more distribution circuits sooner in the EV growth period, followed by a period with no additional upgrade requirements. Following a conservative strategy for circuit upgrades would result in a just-in-time measure, which would require a gradual and ongoing need for upgrade investments over a longer timeframe.*

- b. **Smart charge management (SCM):** Smart charge management can defer upgrading. For the selected SCE feeder, the deferment potential of smart charge management could be between 5 and 15 years over the 2021–2050 period. The value for this deferment of a secondary transformer would be a cumulative benefit of over \$300,000 for the Mallet distribution feeder analyzed. Expressed in \$/EV per year, the SCM benefit is approximately 77.
5. Proposed are next steps to enhance the modeling capabilities to include EV market adoption projections for mid- and heavy-duty vehicles as well as automating the developed capabilities for broad access by community leaders and distribution planning engineers.

Author's comment: It is assumed that SCM includes using specialized EV tariffs with late night to early morning reduced rates to incentivize charging at this time. This will defer distribution upgrades for a time, but currently distribution transformers cool down overnight, especially in the hottest months of the year. As EVs fill in this load-dip, we will probably see more distribution transformers start to fail, requiring upgrades.

PG&E has two EV tariffs, which are linked below. It is also assumed that other California Investor-Owned Utilities (including SCE) have similar tariffs.

EV (Sch): Residential Time-Of-Use Service for Plug-In Electric Vehicle Customers
[https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_SCHEDS_EV%20\(Sch\).pdf](https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_SCHEDS_EV%20(Sch).pdf)

EV2 (Sch): Residential Time-Of-Use Service for Plug-In Electric Vehicle Customers
[https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_SCHEDS_EV2%20\(Sch\).pdf](https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_SCHEDS_EV2%20(Sch).pdf)

5.2. Tesla Supercharger V4

Additional details are emerging regarding the new Supercharger version.

...The V4 Supercharger is Tesla's latest iteration of its industry-leading EV charging network, and with the recent introduction of non-Tesla vehicle charging in the U.S. to qualify for government incentives, the automaker is going forward with some major changes.⁸

...The charging cables were now extended so that non-Tesla vehicles can charge with ease. This was a commonly reported problem in the U.S. as non-Tesla vehicles started to use the Superchargers.

...Increase charging speed... V4 Superchargers were capable of more power, but the vehicles' architecture only allows for certain speeds...

Tesla will make the CCS adapter built into the frame of the V4 Supercharger, which will allow non-Tesla vehicles to charge without an adapter...

Additionally, charging speeds are expected to be up to 350 kW in roughly one year...the Cybertruck, which will be the first Tesla vehicle capable of increased charging speeds thanks to a new 1,000-volt architecture...

⁸ Joey Klender, Teslarati, "Tesla V4 Supercharger details continue to spill:" April 4, 2023, <https://www.teslarati.com/tesla-v4-supercharger-details-spill-ccs-350kw-charging/>

6. Upcoming EVs

Outside of Mr. Farley's T3 (see section 4), I only found the following information:

6.1. VW's Scout & ID. Buzz

*VW has confirmed it will build a new battery factory in Canada that will supply components for the Scout SUVs and trucks that will be built in South Carolina. The company says the St. Thomas, Ontario factory... will start producing batteries in 2027. Scout production is scheduled to start in 2026, so we're not sure what VW's battery plans are for the initial launch of the Scout models. This new battery plant is part of Volkswagen's PowerCo subsidiary that is also working on establishing similar facilities in Europe and Asia.*⁹

The South Carolina EV plant will be VW's second vehicle production facility in the U.S., but it won't make anything but Scout models.

VW's board of management has announced that the company will build a new assembly plant for Scout vehicles in Blythewood, South Carolina, at a cost of \$2 billion. The plant is expected to begin producing an electric pickup truck and "rugged" SUVs with the Scout name in 2026. The new Scout EV plant will create an estimated 4000 jobs and be able to make over 200,000 vehicles a year when fully operational. These will all be Scout vehicles, not EVs for other VW brands, a VW spokesperson told Automotive News.

VW currently operates a factory in Chattanooga, Tennessee. The company announced last May that it will spend over \$7 billion in North America over five years to "boost its product portfolio, regional R&D, and manufacturing capabilities."

Volkswagen started building the ID.4 in Chattanooga in July 2022, with plans to produce 7000 EVs a month. This number should increase throughout 2023. The automaker also started up a battery engineering laboratory in Chattanooga last year and has said it intends to "build up" battery cell production in the U.S.

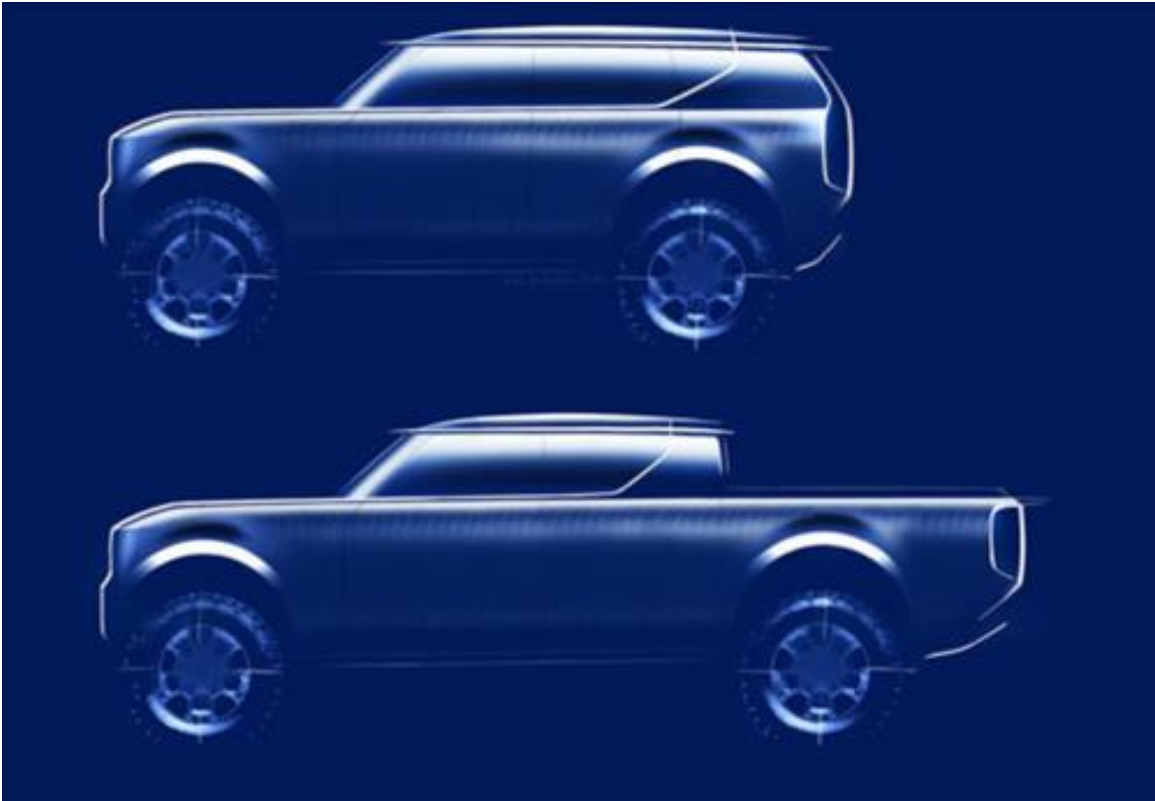
The new Scout plant fits in with other commitments VW made as part of the \$7.1 billion announcement from last May. At that time, VW said it would launch not only the American-assembled ID.4 in 2022 but also the ID. Buzz in 2024 and "new electric SUVs from 2026..."

VW took control of the Scout brand in 2021 when it acquired Navistar (which was the successor to International Harvester, which created the original Scout). VW officially revived the brand in 2022.

Scout Motors CEO Scott Keogh, formerly CEO and president of Volkswagen Group of America, wrote about the plant on LinkedIn and said that "What started in 1960 comes full circle today. Scout is once again reimagining the adventures that an off-road vehicle can deliver – only this time, it's with an all-electric platform. Today, we are closer than ever to putting an important American icon on the road."

⁹ Sebastian Blanco, Car and Driver via MSN, "VW's New Brand, Scout, Will Build EV Pickups and SUVs in the U.S." March 13, 2023, <https://www.msn.com/en-us/autos/news/vw-s-new-brand-scout-will-build-ev-pickups-and-suvs-in-the-u-s/ar-AA18dhhr?ocid=msedgntp&cvid=ae298e9173124028b3c7736cbcee634b&ei=23>

Nowhere in these factory announcements did we learn any details about the vehicles themselves, but Keogh's words hint at some all-electric outdoor fun is on the way. "Scout has always been the vehicle that takes your family camping and also shows up on the job site every morning," he wrote. "This is not changing. Scout's versatility remains intact, and America's love of driving will be revived.



Volkswagen Scout EVs, © Volkswagen

Author's comment: I was looking for a recent image of the ID,Buzz and found a pretty good article with several good images instead. Excerpts from both are below.

In the United States, the 2024 VW ID. Buzz will hit roads in 2024. It will be available at Volkswagen dealerships throughout the country. Volkswagen will announce pre-order and reservation information at a later date.¹⁰

Car and Driver estimates that the ID. Buzz will have a starting price of around \$40,000.

Buyers of the ID. Buzz have a choice of two electric motor configurations. A single-motor rear-wheel drive version generates 201 hp, and a dual-motor all-wheel drive version produces 295 hp.

¹⁰ Mark Putzer, MotorBiscuit, "2024 VW ID. Buzz: Features, Specs, and Color Options — New Electric Van!," March 14, 2023, <https://www.motorbiscuit.com/2024-vw-id-buzz-release-date-price-specs/>



2024 VW ID. Buzz | Volkswagen



2024 VW ID. Buzz | Volkswagen

Car and Driver estimates that the driving range of the ID. Buzz will be at least 260 miles. For charging capabilities, Volkswagen claims that the ID. Buzz “will be able to charge from 5 to 80 percent in as little as 30 minutes” when plugged into a DC fast charger...

7. EV's in Alaska?

TOK, Alaska — Alaska's rugged and frigid interior, where it can get as cold as minus 50 degrees Fahrenheit, is not the place you'd expect to find an electric school bus.¹¹

But here is Bus No. 50, with a cartoon horse decal on its side, quietly traversing about 40 miles of snowy and icy roads each day in Tok, shuttling students to school not far from the Canadian border.

Tok, Alaska is about 200 miles northeast of Anchorage, and just west of the Yukon border.

It works OK on the daily route. But cold temperatures rob electric vehicle batteries of traveling range, so No. 50 can't go on longer field trips, or to Anchorage or Fairbanks.

¹¹ Tom Krisher and Mark Thiessen, Associated Press, “Global race to boost electric vehicle range in cold weather,” 3-12-2023, https://madison.com/news/national/global-race-to-boost-electric-vehicle-range-in-cold-weather/article_fbd43acb-f028-55c0-8a03-600e7c0711a4.html

It's a problem that some owners of electric passenger vehicles and transit officials are finding in cold climates worldwide. At 20 degrees Fahrenheit, electric vehicles just don't go as far as they do at the ideal 70 degrees, so longer trips can be difficult in the coldest weather. Part of it is that keeping passengers warm using traditional technology drains the battery.

Some automakers and drivers fear lower battery range in the cold could limit acceptance of electric cars, trucks and buses, at a time when emissions from transportation must go down sharply to address climate change. There is hope. Scientists are racing to perfect new battery chemistries that don't lose as much energy in cold weather as today's lithium-ion systems.

Also, cars equipped with efficient heat pumps don't lose as much range in the cold.

"It is a problem to have batteries in cold weather, and we have a pretty cold climate, one of the coldest in North America," said Stretch Blackard, owner of Tok Transportation, which contracts with the schools.

When the temperature hits zero, his cost to run Tok's electric bus doubles. Tok has among the highest electricity prices in the nation.

In the coldest weather, 0 down to minus 10 Fahrenheit, the electric bus costs roughly \$1.15 per mile, versus 40 cents per mile for a diesel bus, Blackard said. The cost of the electric bus drops to about 90 cents a mile when it's warm, but he says the costs make it unworkable and he wouldn't buy another one...

Author's comments: Having worked with utilities in Alaska, I know they have a problem with the cost of electricity, especially in small communities, like Tok (Population, 1,243 in the 2020 census). Renewables do hold some promise in reducing this burden:

- In summer months solar energy works really well, but pretty much not at all in winter.
- Wind-power works OK throughout the year, but must be shut down in very cold weather.¹²
- Although the reference 12 paper explores wind-diesel hybrids, and these have better economics than just diesel generators, if an area has forests (Tok does), they might also consider wind-biomass hybrids (woody-biomass fueled boilers with steam-turbine prime movers for generation).

Back to the original issue of Cold-Weather EVs. With a reasonable price of electricity, EV's can use the following strategies during the coldest weather:

- Pre-heat the cabin and batteries before starting a trip.
- Use an on-board heat pump for the above pre-heating as well as normal cabin heating (on trips). External pre-heating power can be provided by the charger.

¹² See "Cold Weather Renewables," <https://energycentral.com/c/cp/cold-weather-renewables> Note I checked most of the important links in this presentation and they still work.

8. Highest Performance EV Batteries

Let's say you are one of the world's largest maker of high performance cars. And also you are part of one of the largest automotive corporations in the world that also hosts other firms that make high-performance and luxury brands. Finally, let's say that you hear about a new development that substantially boosts the performance of EV Batteries, would you invest in a company that has that technology. Ha-ha, silly question!

Electric vehicle battery startup Group14 has raised \$400 million from a group of investors led by Germany's Porsche, the firm said on Wednesday.¹³

Part of that money, which boosts Group14's valuation to more than a billion dollars, will be used to build a second battery materials factory in eastern Washington state, a few hours from the firm's current site in Woodinville, outside Seattle, Chief Executive Officer Rick Luebbe said in an interview.

Luebbe described the firm's silicon-carbon anode material as "transformational technology" that will enable EV batteries to charge more quickly and hold more energy than those that use graphite.

Most of the lithium-ion batteries in today's EVs use anodes made of graphite, which mainly comes from China with smaller quantities from Canada and Japan.

Because Group14's silicon-carbon anode material enables lithium-ion batteries to hold up to 50% more energy, Luebbe said they can provide the same range as current graphite-based batteries, but with fewer cells, thus reducing the overall cost and size of the battery pack.

Author's comment: I've written on another viable lithium-ion battery startup with high-silicon anodes lately. See the post linked below:

Lithium-Ion Battery Breakthroughs: *There is certainly room in the lithium-ion battery market for a design that offers substantially higher energy density than standard Lilon batteries, and the first subject of this post, NanoGraf, certainly offers that.*

This post will also explore several new battery technologies that will allow the optimization of various lithium-ion (a.k.a. Lilon) battery components. The overall goal is to end up with a family of these batteries that are both safer, less expensive, and have better performance.

<https://energycentral.com/c/ec/lithium-ion-battery-breakthroughs>

Initially NanoGraph (from the earlier post linked above) is not going to enter the EV Market, but rather go after higher-value markets. It sounds like Group14 will also enter these high-value markets, but given the scenario spelled out at the beginning of this section, I believe that they will concurrently enter the EV Market.

¹³ Paul Lienert, Reuters, "Porsche leads \$400 million investment in EV battery startup Group14," May 4, 2022, <https://www.reuters.com/business/autos-transportation/porsche-leads-400-million-investment-ev-battery-startup-group14-2022-05-04/>

9. Tesla's First Quarter Results

A week before this paper's posting date these came in.

In the first quarter, Tesla produced 440,808 vehicles and delivered 422,875. That's a new record.¹⁴

Tesla's earnings per share for the first quarter of 2023 was listed at \$0.85 (matched expectations).

Tesla posted revenues of \$23.33 billion (slight beat).

Revenue grew 24% YoY in Q1 to \$23.3 billion.

Operating income decreased YoY to \$2.7 billion in Q1, resulting in a 11.4% operating margin.

¹⁴ Simon Alvarez, Teslarati, "Tesla (TSLA) Q1 2023 earnings results: \$23.3B in revenue, 19.3% non-GAAP gross margins," April 19, 2023, <https://www.teslarati.com/tesla-tsla-q1-2023-earnings-results/>