

# EV Application Shakeout – Part 2

*By John Benson*

*January 2021*

## 1. Introduction

This series focuses on the entire EV Market, including:

- Road-going vehicles - Part 2
- Off-road vehicles (construction and agricultural) – Part 1
- On-track vehicles – Part 1
- Flying vehicles – Part 2
- Marine vehicles – Part 1

In Part 1 we focused on simple and hybrid technologies, and the above indicated market segments. A link to Part 1 is below.

<https://energycentral.com/c/ec/ev-application-shakeout-%E2%80%93-part-1>

In Part 2 we will focus on (1) Road-going vehicles; (2) Flying electric vehicles and how recent developments by Tesla may bootstrap this stalled market, (3) other recent developments by Tesla and (4) a potential Tesla competitor.

## 2. Road-Going Vehicles

If there was any doubt that the vast majority of road-going electric vehicles were going to use (only) batteries, Tesla has reduced this to a tiny niche. Elon Musk recently indicated:

*Getting a range of let's say 500 km is I think quite easy, trivial to be frank, for a semi-truck and this is assuming a truck that is pulling a load of 40 metric tons. If you want, for long-range trucking, you can take the range up to, we think, easily 800 km, and we see a path over time to 1,000 km range for a heavy duty truck.<sup>1</sup>*

1,000 km is about 620 miles, which would be a reasonable day's drive. This leaves only very long distance trips (that would use a team of two drivers) which might benefit from longer ranges. It is unknown if this niche would be large enough to sustain one or more participants. However Elon has already said he would license his technology to other manufacturers, so a small specialty manufacturer might use Tesla batteries and drive train, plus add a fuel-cell range extender system to an existing semi-tractor.

## 3. Flying Vehicles

I covered this a bit more than a year ago with the post described and linked below.

**Flying Cathodes and Anodes Everywhere:** As I started researching this paper I quickly determined that there is a surprising range of flying EVs that transport humans

---

<sup>1</sup> Fred Lambert, Electrek, "Tesla Semi electric truck to have up to 621 miles of range, says Elon Musk", Nov. 24th 2020, <https://electrek.co/2020/11/24/tesla-semi-electric-truck-621-miles-range-elon-musk/>

(as opposed to unmanned aerial vehicles (UAVs)) that are starting to enter various markets, and that is what this paper is about.

<https://www.energycentral.com/c/ec/flying-cathodes-and-anodes-everywhere>

When I researched developments since I posted the above linked article, I discovered there were many “future concepts” and a few EVs based on modified small IC-powered airplanes that actually flew (albeit for a very short distance). The good news is that the above paper is still up to date. The bad news is that none of the future concepts have actually taken-off (pun intended).

The second bit of good news that there are several advances that have brought the technology for battery electric flying vehicles (read: short-range commuter passenger-carrying aircraft) closer to reality.

Potential advances are coming from one place – Tesla, as described in the three subsections below.

### **3.1. Advanced high capacity lithium-ion batteries.**

Any flying EV needs to be as light as possible, especially the on-board batteries. The latest road-going EV designs from Tesla plan to use high power-to-weight ratio batteries (high nickel design) among other optimizations, as can be seen in in section 2.1.1 of the earlier post described and linked below.

**Battery Day – Part 1:** Since Elon finally had Battery Day on September 22, I am posted Part 1 on 9/28 and covered this event and other Tesla information.

<https://energycentral.com/c/cp/battery-day-%E2%80%93-part-1>

### **3.2. Structural batteries**

The structural battery design will be used in the “skateboard” primary structural element of future Tesla Model Y, Cybertruck, and Semi. Elon was quoted by this source:<sup>2</sup>

*Battery pack will be a bonded structure with cells providing shear transfer between steel upper & lower face sheets, eliminating most of the center body parts while providing better torsional rigidity & improved polar moment or inertia. This is a major breakthrough.*

Go through the link to a Tesla page below and activate the video to see the skateboard going together.

<https://www.tesla.com/battery-jobs>

Although the idea of combining batteries with structural elements would greatly reduce the overall weight of flying EVs, this may require some significant redesign of existing future concepts. See the next subsection for details.

### **3.3. Advanced Structures**

Many people think that the Tesla Model Y (small SUV) is basically a redesigned Model 3 (small sedan). It's not. It incorporated some advanced structural elements (including,

---

<sup>2</sup> Fred Lambert, Electrek, “Elon Musk confirms Tesla’s new structural battery and cells are first going to Model Y...”, 10/7/20, <https://electrek.co/2020/10/07/elon-musk-tesla-structural-battery-cells-model-y-giga-berlin/>

eventually, structural batteries). Some of these required collaborating with SpaceX, plus *the world's biggest casting press*.<sup>3</sup>

In order to discover how these structures might be applied to aircraft, one needs to look at how modern passenger aircraft are built.

A modern airplane uses a semi-monocoque design for its main structure (or fuselage). The fuselage is mainly tubular, but its inner structural elements are frames and stringers (a.k.a. longerons). In assembling the fuselage, *a series of frames in the shape of the fuselage cross sections are held in position on a rigid fixture. These frames are then joined with lightweight longitudinal elements called stringers. These are in turn covered with a skin of sheet aluminum, attached by riveting or by bonding with special adhesives*.<sup>4</sup>

See the picture below showing the details of a 747 Fuselage.



The above stringers look like they are probably extruded or rolled from sheet-metal, but the frames look like they might be candidates for structural batteries (assuming the batteries can be on their sides).

Also the sections of the wings would be candidates for structural batteries.

There is another vehicle that uses a structure-design similar to the above pictured 747, the Falcon-9 booster from SpaceX.

### 3.4. Longer Range Flying EVs

I believe these will mainly come from airplanes that use very-low greenhouse gas fuel. This will probably be green ammonia used in turbo-fans. This fuel may be used in combination with two other technologies: (1) electro-fans (high power electric motors packaged in aero-fans), and advanced high performance automotive batteries.

---

<sup>3</sup> Fred Lambert, Electrek, “Tesla is installing world’s biggest casting machine outside Fremont factory”, Aug. 15, 2020, <https://electrek.co/2020/08/15/tesla-world-biggest-casting-machine-outside-fremont-factory/>

<sup>4</sup> Wikipedia article on “Fuselage”, <https://en.wikipedia.org/wiki/Fuselage>

## 4. Other Tesla Developments

The following are updates on subjects that I have previously posted information on.

### 4.1. Giga Berlin

Although the assembly of this Gigafactory is proceeding rather rapidly, it has not exactly been smooth-sailing. Most have the issues have been Elon adapting to the EU and German Bureaucracy's requirements (and vice versa). Having worked for German and Schweizerdeutsch (Swiss-German) companies most of my career, I know how rigid they can be, and from my reporting on Tesla I know how free-wheeling Elon can be. So chalk this friction up to a major culture-clash.

A recent issue was when forest-clearing operations were stopped over environmental concerns. Then more recently Tesla was required to post a security deposit, which is €100 million (\$120 million) allotted for the potential demolition of the Giga Berlin site if the facility's final permits end up being rejected. Elon has been dodging this requirement by working under interim and partial permits, but this issue has now come to a head:

*Brandenburg's state environmental authority ordered the company to stop clearing trees and outfitting its paint shop after the electric-vehicle manufacturer missed a deadline to make a 100 million euro security deposit, German outlet Der Tagesspiegel reported Friday (12/11).<sup>5</sup>*

In spite of the above issues, Tesla is still targeting late 2021 for completion of Giga-Berlin.

### 4.2. Terafactory Texas

The above factory is also on-track for completion in late 2021, and I have seen no reports of issues (like reported above for the Berlin Gigafactory). Since I grew up in Texas and graduated from Texas Tech University, I know Texans have personalities that are much more compatible with Elon than do Germans.

Currently the main vehicle manufactured in this factory will be the Cybertruck, but Model Ys will also be built here. Although it hasn't been confirmed, I believe this factory will ultimately also birth the Semis because of the Terafactory's design, and the fact the Terafactory will manufacture the required batteries on-site (see "Battery Day..." linked in subsection 3.1).<sup>6</sup>

### 4.3. Tesla's Convoy Mode and EU business

When Elon introduced the Semi in 2017, one of the feature he talked about was the "Convoy Mode". This feature is also known as "Platooning".

*Concept videos shared by Tesla during the Semi's unveiling show one manned Semi leading two unmanned electric trucks along a route. Thus, while it might still take some time before Convoy Mode is rolled out to the company's upcoming fleet of long-haulers,*

---

<sup>5</sup> Tim Levin, Business Insider, "Tesla forced to stop construction of its Berlin Gigafactory over an unpaid 100 million euro deposit, report says", Dec 12, 2020, <https://www.businessinsider.com/tesla-gigafactory-berlin-construction-halted-unpaid-100-million-deposit-2020-12>

<sup>6</sup> Mark Kane, InsideEVs, "Tesla Giga Austin Progress: December 15, 2020", <https://www.msn.com/en-us/autos/news/tesla-giga-austin-progress-december-15-2020/ar-BB1bZjQw>

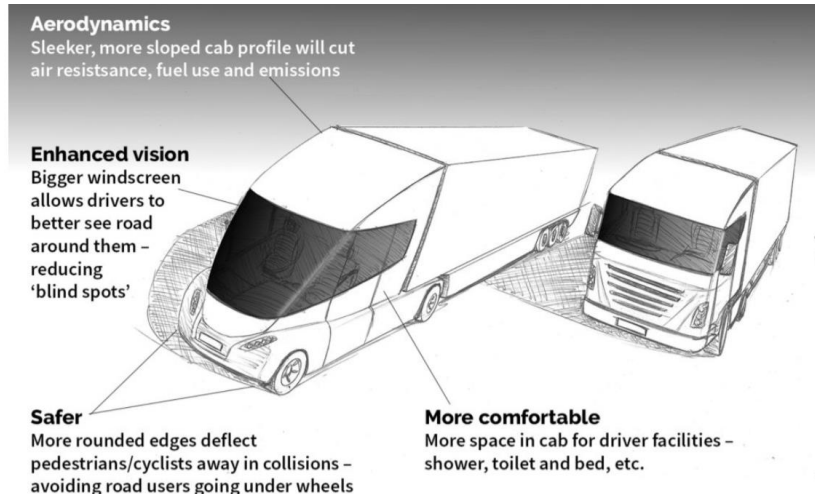
*there might come a time when one driver could effectively drive three trucks — or with further software and hardware improvements — possibly even more.*<sup>7</sup>

There have been several developments in the EU that impact Tesla's Semi. One involves the above described capability: *As for Smart Mobility, the EU Commission wants to proactively create favorable conditions for the development of new technologies. The Commission even stated that it would provide “all necessary legislative tools for their [new technologies] validation.”*<sup>8</sup>

*Support for autonomous vehicles is specifically mentioned in the EU Commission's strategy, giving the Tesla Semi yet another advantage in Europe's heavy-duty vehicle industry. Tesla's advanced driver-assist software, Full Self-Driving (FSD), has been laid with some restrictions in Europe, but that may change in the future.*

*Tesla's autonomous software development will definitely make it to the Semi and one feature in particular could be a game changer in the industry—Convoy Mode. Back in 2017, when Tesla unveiled the Semi, Elon Musk shared that the company's Class 8 truck was already capable of Convoy Mode, which would allow multiple Semis to semi-autonomously draft in close proximity with each other. Since then, Tesla's FSD and Autopilot software have gone through vast improvements, suggesting that Convoy Mode only improved as well.*

However, the main story is that the EU's European Federation for Transport and Environment has targeted Tesla's Semi as their Zero-Emission Lorry (semi) Design of the Future. See the picture and text below.<sup>8</sup>



(Credit: European Federation for Transport and Environment)

*Last year, the EU Parliament voted for a law that required heavy-duty vehicle manufacturers to produce more aerodynamic, energy efficient trucks. Regulations in the law depicted a truck with 80-90 cm (roughly 15 ft.) cabs and bigger windshields for a*

<sup>7</sup> Simon Alvarez, Teslarati, “Tesla Semi gets nod from trucking veteran: ‘(It’s) a good thing for the industry’ ”, Dec 26, 2018, <https://www.teslarati.com/tesla-semi-gets-approval-trucking-veteran-convoy-mode/>

<sup>8</sup> Maria Merano, Teslarati, “Tesla Semi & Convoy Mode are a perfect fit for EU Commission’s updated mobility strategy”, Dec 13, 2020, <https://www.teslarati.com/tesla-semi-convoy-mode-eu-strategy-perfect-fit/>

*better view of the road. The European Federation for Transport and Environment released an illustration of the EU Parliament's ideal heavy-duty vehicle design and it was very similar to the Tesla Semi.*

*Between the EU Commission and EU Parliament, it seems the game has been set for Tesla. The scales seems to tip more in favor for Tesla and the Semi when the Commission's Smart Mobility plan comes into play.*

#### **4.4. Quarterly and Yearly Deliveries**

The following are a repeat of the quarterly deliveries in 2020 with the fourth quarter added, and also repeated are some recent years for context. Considering the challenges presented by the Pandemic and the numbers of EVs delivered are getting really big, I would say the fourth quarter (and 2020) was startlingly good.

- 2014, 31,655
- 2015, 50,517 (First Model X)
- 2016, 76,243
- 2017, 103,091 (First Model 3)
- 2018, 244,920
- 2019, 367,200
- First quarter 2020, 88,400 (up 40% year over year for quarter, first Model Y)<sup>9</sup>
- Second quarter 2020, 90,650 (down 5% year over year for quarter)
- Third quarter 2020, 139,300 (up 44% year over year for quarter)
- Fourth quarter 2020, 181,200 (up 62% year over year for quarter)
- Total 2020, 499,550 (up 36% year over year)

### **5. Nikola Motor Company**

This embryonic company is one of Tesla's many competitors in the E-Trucking Market, albeit one of the few targeting a fuel-cell design and with a futuristic exterior design (see below).

---

<sup>9</sup> Kim Lyons and Sean O'Kane, The Verge via MSN Money, "Tesla fell just short of delivering 500,000 vehicles in 2020", Jan 2. 2020, <https://www.msn.com/en-us/money/companies/tesla-fell-just-short-of-delivering-500000-vehicles-in-2020/ar-BB1cq20f>



I reviewed available information on their proposed semi (the Nikola Two) in subsection 3.1 of the post described and linked below last summer.

We are in the midst of a war-of-words over the future of trucking. The main event is Evil-Elon with his Tesla Semi vs. Mauler Mark Russell with his Nikola One, Two, Tre Punch. There are also many undercard bouts involving old-pros from the internal combustion (IC) Trucking Industry. The referee is likely to be the California Air Resources Board (CARB) Chairwoman Mary D. Nichols, with CARB's Advanced Clean Trucks (ACT) rulebook for knocking out diesel emissions in the state.

In this paper we will review the latest information on the above bouts, the new rulebook, and how IC Trucks will be knocked out by the three-punch combination of ACT, eTrucks and H<sub>2</sub>Trucks.

<https://energycentral.com/c/ec/etrucking>

My main criticism of the Nikola Two in the above linked post was that they provided no information on their fuel cell design, which led me to believe they had not yet selected a design nor manufacturer. They have now remedied this.

From the source linked here.<sup>10</sup>

*General Motors (NYSE: GM) won't take an equity stake in startup electric truck maker Nikola Corp. (NASDAQ: NKLA), ending Nikola's plans for its Badger pickup. But the two agreed to a nonbinding memorandum of understanding to explore using GM's Hydrotec fuel cells in heavy-duty trucks.*

*GM originally planned to take an 11% stake in Nikola in exchange for producing the Badger, which Nikola heavily hyped under founder and former Executive Chairman Trevor Milton. The company would have had to pay GM \$700 million to make the truck. Nikola will refund all order deposits received for the Nikola Badger.*

*Nikola had about \$900 million in cash at the end of the third quarter. Most of that money is dedicated to building Nikola's plant in Coolidge, Arizona.*

---

<sup>10</sup> Alan Adler, Freightwaves, "News alert: GM won't take equity stake in Nikola", Nov 30, 2020, <https://www.freightwaves.com/news/news-alert-gm-wont-take-equity-stake-in-nikola>

*“Providing our Hydrotec fuel cell systems to the heavy-duty class of commercial vehicles is an important part of our growth strategy and reinforces our commitment toward an all-electric, zero-emissions future,” Doug Parks, GM executive director of global product development, purchasing and supply chain, said in a press release.*

*Nikola and GM will discuss Nikola using GM’s Ultium batteries in future models.*