

Tesla Semi battery-electric tractor-trailer

Peter Lobner, 2 April 2020

Elon Musk unveiled the battery-electric Tesla Semi on 16 November 2017. This very streamlined tractor-trailer offers industry-leading aerodynamic performance that helps minimize vehicle energy consumption during freight operations. This enables the battery-electric Tesla Semi to operate at a range of 300 or 500 miles (563 or 807 km), depending on model and size of the battery, with zero carbon emissions. The all-electric Tesla Semi represents a big step toward reducing greenhouse gas emissions from freight operations.

Automation features implemented in this truck are intended to reduce driver workload, improve safety and lay the foundation for future autonomous freight operations.



Tesla Semi. Source: Tesla



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Here are basic statistics on the Tesla Semi:

- Drag coefficient (C_D): 0.36
 - In comparison, a typical diesel truck has a C_D of 0.60 to 0.70. A Bugatti Chiron super sports car has a C_D of 0.38.
 - Adjustable flaps close the gap and streamline the interface between the tractor and the trailer.
 - Truck convoys (platoons) using Tesla's automated lane & distance keeping features will further reduce the average C_D of the trucks in the convoy and improve their fuel economy.
- Four independent electric motors, one on each of the tractor's drive wheels:
 - Regenerative braking recovers energy
 - Coordinated controls improve stability and can prevent jackknifing
- Gross vehicle weight (GVW): 80,000 pound (36,287 kg), which is the maximum GVW allowed on federal interstate highways.
- Range: 300 - 500 miles (483 - 807 km) at maximum gross vehicle weight (GVW) at freeway speeds, depending on battery size.
 - 80% of US truck routes are less than 250 miles (402 km), allowing some out & back missions without recharging.

- 30 minute fast recharge on a future Tesla Megacharger network for trucks will provide 400 mile range. The Megachargers will be more powerful than the existing V3 Superchargers for Tesla cars.
- Energy consumption: < 2 kWh/mile (kilowatt-hours per mile)
 - 300 mile range should require < 600 kWh
 - 500 mile range should require < 1,000 kWh (1 megawatt-hour, MWh)
- Acceleration: 0 – 60 mph (0 – 97 kph) in 20 seconds at max. GVW.
- Hillclimb: 65 mph (105 kph) up a 5% grade at max GVW.
 - A typical diesel truck can do about 45 mph.
- Estimated operating cost: \$1.26 / mile, about 20% less than the typical operating cost for a diesel truck (at a guaranteed electric power cost via the future Megacharger network)



Tesla Semi driver's cockpit. Source: Tesla

In August 2018, a Tesla Semi demonstrated its long-range capabilities on an unaccompanied 2,000 mile (3,219 km) trip from the Tesla Fremont, CA factory to the J. B. Hunt headquarters in Arkansas using the existing Tesla Supercharger network, which has been widely deployed to support Tesla cars.

Road testing the Tesla Semi continues prior to its commercial introduction. The Tesla Semi tractor has been tested with a car carrier trailer (for Tesla cars, what else) and an open flatbed trailer for heavy loads. Tesla Semis on long-distance test runs around the US reportedly have been seen using multiple Superchargers simultaneously to recharge the truck.



Tesla Semi with a car carrier trailer.

Source: Mark Kane, INSIDEEVs.com, 31 March 2019



Two versions of the Tesla Semi tractor.

Source: Fred Lambert, electek.com, 23 October 2019



*Tesla Semi hauling an open flatbed trailer with a heavy load.
Source: Fred Lambert, electek.com, 15 August 2019*

The price of a base 300-mile (483 km) range Tesla Semi is expected to be about \$150,000. The 500-mile (807 km) range model is priced at about \$180,000 and an even higher-priced “Founders Series” model is expected to be available at \$200,000. Many large and small firms have placed orders for the Tesla Semi. However, Tesla has not announced the magnitude of its order backlog. Low-volume production is expected to begin in 2020, with initial deliveries to customers possibly before the end of 2020.

Tesla’s Supercharger and Megacharger networks

Tesla’s existing Supercharger network, originally intended for cars, is being continuously upgraded and expanded.

- **V2 Superchargers:** More than 12,000 V2 Superchargers were deployed worldwide as of March 2019. V2’s split their 145 kW peak power (increased from 120 kW in 2019) between two vehicle chargers. If both chargers are in use, the charging speed of each user can drop by as much as one-half.
- **V3 Superchargers:** Introduced in March 2019, V3’s have a new architecture, similar to Tesla’s utility-scale products, with a 1 MW (megawatt) power cabinet supporting four vehicle chargers at peak rates of up to 250 kW per vehicle. This enables all four users to charge at the maximum rates that their batteries can take. Any excess capacity from a 1 MW power cabinet can be routed to any cars charging at the station, up to

whatever the vehicle and charging station hardware can handle.

As noted previously, the Tesla Semi currently is accomplishing its long-range test drives using the existing Tesla Supercharger network and reportedly is using multiple Supercharger stations for recharging.

Tesla's new Megacharger network has not yet been deployed. However, it likely will be based on the Tesla's utility-scale products, such as the 1 MW power cabinet. Imagine charging the Semi's battery at a 1 MW rate (four times the V3 Supercharger). At the Semi's claimed energy consumption rate of < 2 kWh/mile (kilowatt-hours per mile), a Semi could receive a full 500-mile charge (about 1,000 kWh, or 1 MWh) in about one hour. A few Megachargers at a truckstop definitely will put a drain on the local electric power infrastructure. Changes to the nation's electric power transmission and distribution networks may be required to enable wide employment of Megachargers and similar powerful charging stations for heavy trucks.

In the interim, some Tesla Semi reservation holders are installing dedicated charging stations for their future trucks at their own facilities (i.e., truck depots).

In conclusion:

It is very likely that the Tesla Semi will be a catalyst for change in the freight trucking industry and large orders could be forthcoming if the early models can live up to Tesla's hype. Elon Musk announced that Tesla Semi sales could reach 100,000 within four years of the start of deliveries. I hope he's right, because it would help start an electric Class 8 heavy-duty truck revolution in the freight industry and open a path that could greatly reduce the greenhouse gas emissions from heavy freight trucking operations.

You'll find more information on the Tesla Semi here:

- “Tesla Semi,” On the Tesla website here:
<https://www.tesla.com/semi>
- “Tesla Semi – Tesla’s upcoming all-electric heavy-duty truck – 135 Tesla Semi Stories,” electrek.com, July 2016 – March 2020: <https://electrek.co/guides/tesla-semi/>
- Danny Palmer, “What is the Tesla Semi? Everything you need to know about Tesla's semi-autonomous electric truck,” ZDNet.com, 22 March 2018:
<https://www.zdnet.com/article/what-is-the-tesla-semi-everything-you-need-to-know-about-teslas-semi-autonomous-electric-truck/>
- Avery Thompson, “Tesla's Prototype Semi Traveled Across the Country on Superchargers Alone,” Popular Mechanics, 27 August 2018:
<https://www.popularmechanics.com/cars/trucks/a22841944/teslas-prototype-semi-traveled-across-the-country-by-itself/>

The following video provides additional views and more information on the Tesla Semi:

- “Tesla Semi & Roadster Unveil” (35:03 minutes total, truck unveil ends at 26:00 minutes), Tesla, 14 December 2017:
<https://www.tesla.com/semi>

See the following for more information on Tesla’s Supercharger networks:

- “Introducing V3 Supercharging,” Tesla, 6 March 2019:
<https://www.tesla.com/blog/introducing-v3-supercharging>
- Kyle Field, “A Quick Guide To Tesla’s New V3 Supercharging,” Cleantechnica.com, 16 August 2019:
<https://cleantechnica.com/2019/08/16/a-quick-guide-to-teslas-new-v3-supercharging/>