Tesla Model 3 with Superchargers/Destination-Chargers is the Best Car Ever Made

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Introduction

Definitions

- Gasoline or diesel car (Internal Combustion Engine Vehicle = ICEV)
- Hybrid Electric Vehicle (HEV)
- Plug-in Hybrid Electric Vehicle (PHEV)
- Battery Electric Vehicle (BEV)

Criteria for Best Car Ever Made

What are the criteria for deciding the Best Car Ever Made (BCEM)? Start with these features, not necessary in order of importance, and perhaps modify them and/or add more later:

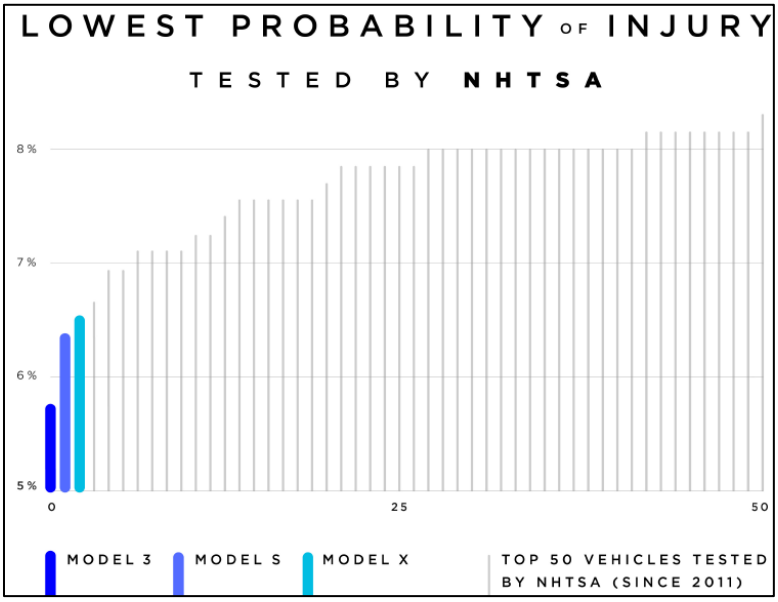
- Safest car on the road
- Least destructive to the environment, including carbon emissions, particle emissions and noise
- Affordable in terms of low initial cost, low fuel cost and low maintenance cost
- Reliable
- Easiest to drive
- Easiest to refuel
- Fuel-usage efficiency
- Minimal maintenance
- Mobile service
- Capable of being driven to any location in reasonable times
- Reasonable driving assistance for safety and comfort
- Easy to learn and use controls
- Higher acceleration than most other cars
- A powerful smart-phone app for controlling the car
- Owner satisfaction
- Attractive to view
- Fun to drive

The conclusion of this study is that the Tesla Model 3 (TM3) is the current BCEM.

Safety

Most BEVs with RWD are safer than ICEVs because there is no heavy engine in front; instead, most RWD BEVs have extensive crumple zones in front to absorb collision energy. For the Tesla-Model-3-AWD version "the subframe is designed to pull the nose of the motor down and out of the way."

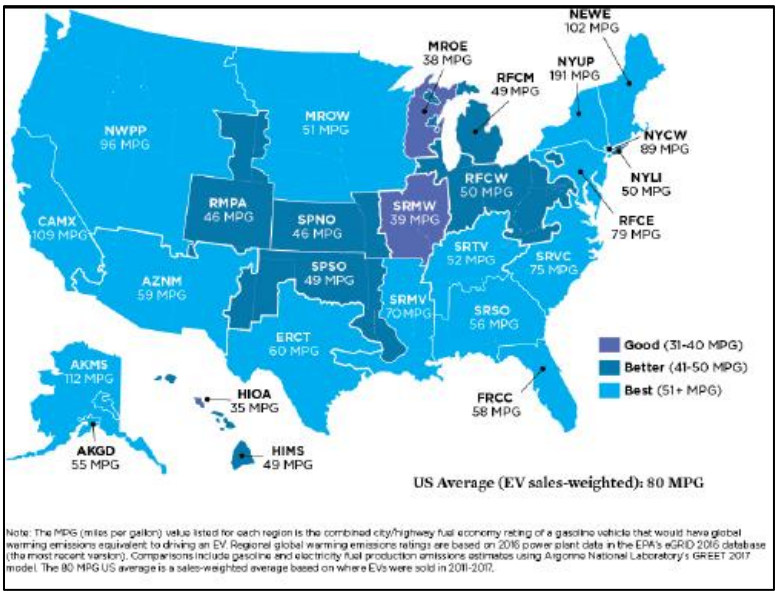
The Tesla Model 3 is rated by NHTSA as the safest car on U.S. roads in terms of probability of injury:



One could argue that the Tesla Model S is not much different than the Tesla Model 3 with regard to safety. However, once the affordability factor is included Model 3 is better than Model S.

Carbon Emissions

The Union of Concerned Scientists has rated the average BEV compared to the average ICEV for carbon emissions in the United States. In 2017 the result was that an average ICEV would have to achieve 73 MPG to match the low emissions of the average BEV which charges from a local electric grid. That number is 80 MPG for 2018 and will continue to increase in future years as the U.S. electric grid is sourced more from solar and wind power. Of course, the number is different for different areas of the U.S. because of differing grid sources as shown in this map:



Even though more carbon emissions occur to build a BEV than to build an equivalent ICEV, after a year or so of driving BEVs are responsible for less emissions than equivalent ICEVs. This is called "Well-to-wheel life-cycle" emissions.

Any BEV is way ahead of any ICEV for this criterion for BCEM.

Of course, if a TM3 owner has a solar PV system at home, any carbon-emissions-equivalent ICEV would have to have infinite MPG!

Initial Cost

The average cost of a new 2019 car, mostly ICEVs, in the U.S. is $37,577. The lowest cost for a TM3 is the Standard version at $37,000. Of course, there are other versions of the TM3 that cost more.

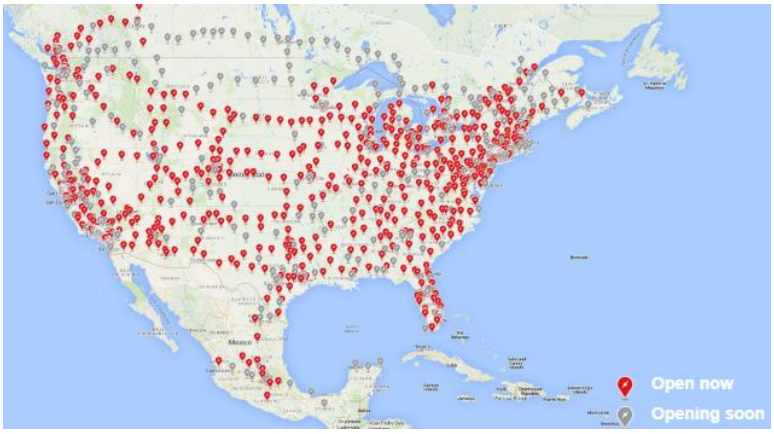
Refueling

A most important feature for deciding the BCEM is how easy and costly refueling is, both for local and long-distance driving. This criterion is misunderstood by many car buyers because they do not understand the high desirability of being able to charge a large BEV battery to full overnight at home.

If there were no gasoline/diesel stations, no ICEV or HEV would be in the contest for the BCEM. There are plenty of gasoline stations, but probably none in drivers' home driveways or garages for easy overnight refueling.

Many drivers of BEVs have the capability of charging their BEVs overnight at home, which cancels the necessity of making trips to smelly and dangerous gasoline stations for refueling. Currently most apartment dwellers do not have that capability. However, when most cars on the roads are BEVs instead ICEVs within the next few decades, as must happen when crude-oil and natural-gas extraction from within the Earth is no longer feasible at a reasonable price, apartment owners will be required by law or social convention to provide that capability. Tesla Urban Superchargers in large cities make it possible for apartment dwellers there to have BEVs.

When on long trips BEVs need fast charging stations on roads and slower charging stations at overnight locations. Currently Tesla is the only car company that provides both of those capabilities with its Superchargers on the road and slower Destination Chargers or level-2 charging stations at hotels, parks and other overnight locations. Overnight charging at these locations usually has no cost to use. Superchargers are located at hotels, shopping centers and gasoline stations, desirable locations. These two Tesla charging capabilities currently allow travel over most of the U.S. on major highways, and that capability is increasing very fast. Soon it will cover the less-used roads in the entire United States. The TM3 can use all of these. A map of U.S. Tesla-Supercharger locations, existing (red) and being built in 2019 (grey):



The current Supercharger (V2) charging rate of 145 kW will soon be increased to 250 kW (V3) for very fast charging.

A map of U.S. Tesla Destination-Charger locations:

This map does not show Destination Chargers being built, which must be a large number.

At most Destination-Charger locations Tesla has installed, through its Charging-Partners program, level-2 charging stations for other BEVs to use in order to increase the capability for all BEVs to travel long distances.

Volkswagen's Electrify America is starting to emulate Tesla Superchargers, with CCS and CHAdeMO fast-charging protocols for other BEVs to use, on major U.S. highways, but likely will never catch up to Tesla. Before too long Tesla probably will have an adapter to allow the TM3 to use the fast CCS charging stations being installed by Electrify America and other charging networks.

Plug-in Hybrid Electric Vehicles (PHEV) share with BEVs the capability of charging overnight at home for local travel, but use gasoline/diesel stations for fuel on long trips. They can be charged overnight at hotels on long trips where level-2 charging stations are available

The Tesla navigation application in the TM3 plans trips showing where and how long to stop at Superchargers and how many charging stalls are available at the next Supercharger, a wonderful help in Tesla traveling! (Electrify America does not yet have this feature for other BEVs. Perhaps it will for future VW BEVs.) Many drivers find that they need to stop for personal reasons more than the TM3 needs to stop to charge. Tesla provides an online program to plan a TM3 trip and there is another excellent smart-phone/computer app to plan BEV trips: A Better Route Planner.

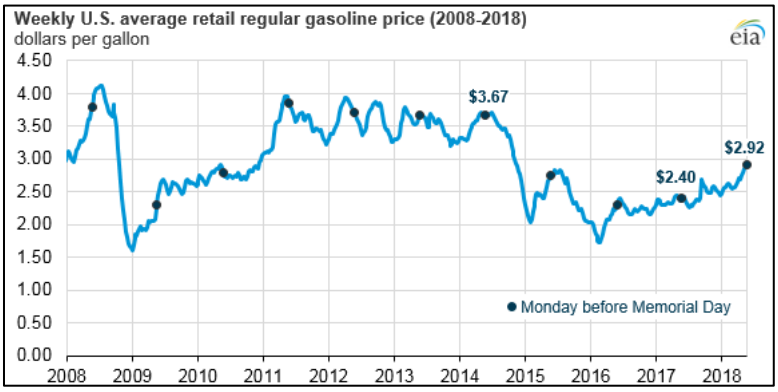
For more information about charging any BEV see http://www.roperld.com/Science/ChargingElectricCarsQuestion.pdf.

Fuel Efficiency

To compare fuel efficiency of ICEVs and BEVs a useful parameter is MPG for ICEVs compared to MPGe for BEVs. MPGe (Miles-Per-Gallon Gasoline equivalent) is the average distance traveled per unit of energy consumed by a BEV. Its calculation uses 33.7 kWh as the electrical-energy equivalent to one gallon of gasoline. The Tesla Model 3 rates from 116 MPGe (AWD version) to 134 MPGe (Standard version). No ICEV or HEV comes anywhere close to that efficiency; the top HEV MPG is the L Eco Toyota Prius at 56 MPG, less than half of the highest TM3 MPGe. There is currently one BEV with a slightly higher MPGe than the TM3 Standard version, the Hyundai IONIQ at 136 MPGe.

Fuel Cost

The average cost of gasoline in the U.S. from 2008 to 2018 was about **$3/gallon**:



Note that gasoline prices have large fluctuations over time.

The average MPG of gasoline cars in 2018 was about 23 MPG. So, the cost per mile for an average ICEV is about ($3/gallon) / (23 miles/gallon) = **$0.13/mile**.

The average cost of electricity in the U.S. for 2018 is about **$0.125/kWh**, which is very stable over time. So, the cost per mile for the TM3 is:

- For the AWD TM3: ($0.125/kWh) x (33.7 kWh/gallon) / (116 miles/gallon) = **$0.036/mile**.
- For the Standard TM3: ($0.125/kWh) x (33.7 kWh/gallon) / (134 miles/gallon) = **$0.031/mile**.

The ICEV/TM3 fuel-cost ratio is about 3.6 for the AWD TM3 and about 4.2 for the Standard TM3.

Ease of Driving

As for all BEVs the large TM3 1054-lbs traction battery is under the car seats, giving the car a low center of gravity, which provides great driving characteristics. Many reviewers praise the driving characteristics of the TM3.

The TM3 central 15" screen has most of the functions of the car on it, including options to change the driving characteristics. It takes a while to learn how to use it, but after that it is very easy to use. The two scroll wheels on the steering wheel and the two stalks on the sides of the steering wheel make using Traffic Aware Cruise Control, the "Autopilot" semi-automatic driving option, the sound system and a few other functions very easy to use. A driver can change several features of the TM3 to decide which is best for the driver's situation. After driving a TM3 for a few thousand miles, driving a recent gasoline car seems like going back one or two car generations.

The high acceleration of the TM3 allows a driver to escape dangerous situations quickly and move out of heavy traffic quickly. It is handy when the TM3 is first in line at a red light in order to quickly move away from traffic behind it, using very little extra energy.

The optional "Autopilot" and "Full Self Driving" software allow automatic lane keeping, automatic lane changing and automatic highway exiting, which makes driving on long trips much less tiring. Of course, these features have extra costs.

Smart-Phone App

The Tesla smart-phone app has many functions for the TM3; it is updated over the Internet with more functions regularly. It can be used as the key to the TM3, unlocking, starting and locking the car without any driver action. Also, it can be used to slowly move the TM3 with the driver outside the car. There is an RFID card and a key fob to use if a phone quits working.

Maintenance

BEVs require very little maintenance, much less than ICEVs require. There is no engine, no transmission, no muffler and catalytic converter, no oil changes, etc.

The large battery in the TM3 is warranted for 8 years and 100,000 to 120,000 miles, depending on the version, with minimum 70% retention of battery capacity over the warranty period. Tesla batteries are known to lose minimal capacity over time. Battery expert Jack Richard states that the TM3 is the "best battery ever built to date."

Car expert Sandy Munro states that the TM3 motor is "smaller, lighter, more powerful and more efficient." than other BEV motors. Large electric motors run 24 hours a day for years in industry with very little maintenance needed.

An important feature of Tesla cars that no other car company has been able to have yet is no-cost Internet software upgrades at owner locations. A Tesla car can be thought of as a "computer on wheels", which makes it easy to upgrade the extensive software. Here is a list of upgrades in eight downloads over ten months after purchase for one owner of a TM3 Long Range RWD BEV: http://www.roperld.com/Science/TM3RoperUpdates.pdf.

Mobile Service is designed to take care of about 80% of repairs. Mobile Service was doubled in 2018 because of the increasing production of the TM3.

Owner Satisfaction

Tesla BEVs topped the list of car-owner satisfaction by Consumer Reports for years 2017, 2018 and 2019.

When the TM3 was first starting to be made there were complaints by owners of some defects. Similarly when the TM3 production quickly went from about 2000/week to about 4400/week there were complaints by owners of some defects. Because of the capability of software downloads, remote diagnostics, smart alerts and Mobile Service Tesla was able to quickly fix most of the defects.

Attractiveness

A few pictures are worth many words:

Fun to Drive

Many drivers of the TM3 state that it is so much fun to drive that they daily try to think of places to drive it.

Conclusion

Putting all the items listed above together it is clear that the TM3 is the BCEM.

It may be that when the Tesla Model Y, a midsize SUV similar to the TM3 sedan, becomes available in a year or so it will be the BCEM.

Or, perhaps some other car company will spend billions of dollars to make a car similar to the TM3 and a charging network similar to Tesla's, or buy into the Tesla charging network. That would be great for the world's future if it did!