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Comparing Range between the Tesla Model S and the Chevrolet Bolt

Gabriel Shenhar

Consumer Reports Auto Test Center, 3 Hall Kilbourne Road, Colchester, Connecticut 06415, USA

gshenhar@consumer.org

Summary

As of writing this, the least expensive electric vehicles (EVs) that deliver a driving range that makes them a viable alternative to a conventional gas-powered car are the Chevrolet Bolt and Tesla Model S 75. This paper outlines the process of determining their respective driving range, arguably the most important factor for EVs in the eyes of consumers. The Bolt and Model S have a claimed range of 238 (383 km) and 259 (417 km) miles, respectively. Consumer Reports, a non-profit product testing organization, has determined their range through calculations as well as validation through on-road testing.

Keywords: Tesla, Model S, Chevrolet, Bolt, Range, Consumer Reports, Charging, Range prediction, On-Road Testing

Background

Originally, the comparison was supposed to be between the Tesla Model S 60D and the Chevrolet Bolt on the premise that both cars have a 60 kWh battery. Subsequently, Tesla discontinued the 60 and gave customers the option of upgrading to 75 via an over-the-air software update. The 60 actually had a 75 kWh battery from the outset, but was limited to a usable 60 kWh. Given that the 60 is now obsolete, we present the data that pertains to the Model S 75. Even with this change, the notion that these two models are the least expensive long range EVs still holds true. The Chevrolet Bolt has a starting price of $36,620 and the Tesla Model S 75 starts at $69,500 in the U.S.

After a 2000 mile (3218 km) break-in and observations regarding range, charging times, and other performance aspects in the real world during normal commuting by staff members, we start formal testing. Ultimately, our process of determining range consists of three layers.

The first layer is a regimented drive on a predetermined route of 75 miles (120 km), the least common denominator among EVs for establishing a correction factor between predicted and actual range. Using that, we extrapolate our calculated range. However, we’ve found that this is not the definitive method of determining range.

The more important layer is validation by on-road driving within predetermined parameters until the car goes into its reduced power mode.

The third layer is a reality check. It has more of an anecdotal value since it relies on data collected during the car's initial break-in period, when the car is driven under a variety of conditions, including diverse weather conditions.

Each one of these layers will be discussed:

1 Predicted versus actual range

In order to establish a correction factor between predicted and actual range, we drive EVs on a predetermined route of 75 miles (120 km). The route consists mainly of a four-lane highway with mild elevation changes, and we keep the speed to a constant 65 mph (105 kmh) for as much as possible using cruise control. We turn the AC compressor off to remove that variable out of the equation. The ambient temperature window used is between 60 and 80^{o} F (15 and 27 ^{o}C) to minimize the effects of extreme temperatures. Often, the predicted range of a given car is based on the rated range as established by the Environmental Protection Agency (EPA), a US government agency that certifies all new vehicles' energy consumption. The rated range is often a proxy for battery state-of-charge (SOC).

Here are the steps to determine the ratio between predicted and actual range:

Distance (driven) + Remainder of range = Distance as if driven to 0

Ratio of initial to final = Distance as if driven to 0 ÷ Initial predicted range

Predicted range used = Initial predicted range – Remainder of range

Actual vs. Predicted ratio = Distance (driven) ÷ Predicted range used

1.1 Example (Tesla Model S 75D):

Table 1: Arriving at actual vs. predicted range

Miles Predicted	257
Actual miles Driven	72.5
Rated range left (remainder)	178
Rated as if run to 0	*250.5*
Ratio (initial to final)	*0.97470817*
Predicted miles used	*79*
Actual vs predict ratio	*0.91772152*
Adj range vs. pred (mi)	***235.85***

R = Range

D = Distance

I = Initial

F = Final

$$72.5\ (D_{driven}) + 178\ (R_{remainder}) = 250.5\ (\textit{As if run to 0}) \quad (1)$$

$$0.9747\ (Ratio_{F\ to\ I}) = 250.5 \div 257 \quad (2)$$

$$79\ (R_{used}) = 257\ (R_{Initial}) - 178\ (R_{remainder}) \quad (3)$$

$$0.9177\ (Ratio_{Actual\ vs.\ Predicted}) = 72.5\ (D_{driven}) \div 79\ (R_{used}) \quad (4)$$

Therefore in this case: 0.9177 × 257 = 235.85

The takeaway is that, often, the ratio between the rated and actual range is about 10%. In other words, when starting with a predicted 100 miles of range, expect to get only 90 miles of actual driving.

1.2 Example: Chevrolet Bolt

Instead of a range indicator based on rated range, which serves as a proxy for the battery's state of charge (SOC), the Bolt's range indicator is affected by how the car had been driven previously. It even displays two additional range predictors for best and worst case scenarios. Because of this, we had to monitor the Bolt's SOC and extrapolate its range based on how much distance it had covered and what percentage of the battery it had consumed.

Table 2: Calculating Bolt's range

SOC full	96.1
SOC low	9.8
SOC range (bet. upper & lower limits)	*86.3*
Miles driven	70.45
SOC at end of trip	70.2
SOC used	*25.9*
Times car can cover same distance	*3.332046332*
Miles within SOC (r)	***234.7426641***

$$\text{Usable SOC range between Full and Low} = \text{SOC (r)} \quad (5)$$

$$\text{SOC (r)} = 96.1\% - 9.8\% = 86.3\% \quad (6)$$

$$\text{SOC used} = 96.1\% - 70.2\% = 25.9\% \quad (7)$$

$$\text{Times car can cover same distance} = 86.3 \div 25.9 = 3.332 \quad (8)$$

$$\text{Miles within usable SOC range} = 3.332 \times 70.45 = 234.74 \quad (9)$$

Using a different method but adhering to the same principle as with the Tesla, we were able to arrive at a range that is a function of driven distance and the battery usage that corresponds to that distance. While this result comes close to the EPA's 238 mile range, we don't believe it's consistent enough when compared to other EVs because there's more usable range and full propulsion power available even at a lower SOC than 9.8%.

2 Reality Check

As a reality check, we monitor driving patterns collected from each trip the car completes. As opposed to the previous section, these trips are not regimented and are subject to a variety of drivers, driving patterns and temperatures. Here's a sample from multiple runs with the Chevrolet Bolt:

Table 3: Chevrolet Bolt Break-In Period

Miles predicted (R initial)	196	212	221	187	197	Cumulative (mi)			
Actual miles driven	161	73	127	84	77	522			
Rated range left (remainder)	57	128	64	129	119				
Est as if run to empty	*218*	*201*	*191*	*213*	*196*				
Predicted use (initial-remain)	*139*	*84*	*157*	*58*	*78*	516			
Ratio Actual vs. Predicted	*1.158273381*	*0.869047619*	*0.808917*	*1.448276*	*0.987179*	*1.011627907*	**238**	**EPA Range**	
							240.7674	**Adjusted Range**	

In order to establish a ratio between the actual and predicted range, we compare the actual miles driven to the predicted use, which is the range displayed initially at the start of the trip minus the remainder range displayed at the end of the trip.

$$\text{Ratio (act vs. predict)} = \Sigma \text{ Miles driven} \div \Sigma \text{ (R initial} - \text{R remainder)} \qquad (10)$$

As demonstrated above, it is clear that the Bolt’s rated and claimed range is very close to the anecdotal real world data. In this case, the range derived from trips taken exceeds the claimed range, which means that the Bolt’s official range is on the conservative side.

3 Validation

As seen above, a combination of a consistent driving pattern and extrapolated calculations can yield an idea of range. But since Consumer Reports (CR) is data driven and evidence based, we believe it is necessary to prove the range by driving each EV until propulsion power is reduced. We do not believe in driving EVs until they are stranded as much as we believe gas cars should not be. Both the Tesla Model S 75D and the Chevrolet Bolt were driven following one another on the identical route and in the same environmental conditions.

Since driving an electric car requires a fair amount of forward planning regarding when and where to charge, we think it behoves us to peg a uniform margin of error, which we believe is when the car goes into reduced power mode but still able to propel itself to a nearby outlet. After all, each manufacturer may set the low battery level warning at a different threshold, as is common with gas cars.

Table 4: Findings from validation run

	Model S 75D	**Bolt**
Temp F (average)	78	78
Odometer start (miles)	2548	2500
Predicted Range at start	258	247
Range indicator at end	0	Low
Miles driven until 0/Low	**229.7**	**236.0**
Add’l driving before reduced power	5.3	16.3
Total trip length, miles	**235.0**	**252.3**
EPA rated, miles	259	238
CR's testing, miles (km)	**235 (378)**	**250 (402)**

The on-road validation run was conducted in conditions that are close to best-case-scenario with an average temperature of 78 ^{o} F (25.5 ^{o} C) through the drive and with the air conditioning compressor off. After covering nearly 230 miles (370 km), the Tesla displayed 0 in its range indicator and kept going. At 235 miles (378 km) it began to cut the power. The Bolt covered 236 miles (380 km) before the range indicator displayed “Low” which came right after displaying 15 miles of remaining range at 9.8% SOC. It then kept on going for more than 16 miles before displaying “Propulsion Power Reduced” for a total of 252.3 miles (402 km).

In both cases the range deviates from the one pegged by the EPA, which is also the range claimed by each respective manufacturer. Since driving at reduced power can have a safety implication, we peg the maximum range at that very point. For the Model S 75D’s the range is 235 miles (24 less than the EPA’s) and for the Bolt it is 250 miles (12 more than the EPA’s).

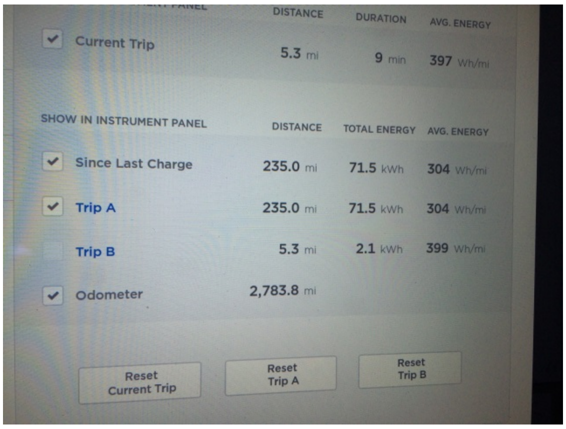

Figure 1: Tesla with 235 miles

Figure 2: Bolt with 252.3 miles

4 Facts and Figures

Table 5: Consumption, performance & specs

Energy consumption & charge time	**Tesla S 75D**	**Chevrolet Bolt**
kWh to replenish	82.98	66.48
Charge time (240 V/32amp) hh:mm	12:25	10:00
Consumption mi/kWh (AC) [km/kWh]	*2.83 [4.56]*	*3.73 [6.00]*
Specs & performance		
Weight lb/kg	4,595/2,088	3,547/1,612
Horsepower	315	200
Acceleration 0-60 mph (kmh)	5.1	6.8
Top speed, mi (kmh)	130 (209)	92 (148)

5 Conclusion

Range is a key factor when considering an EV. So far, only Tesla models and the Chevrolet Bolt have batteries that pack enough capacity to provide what could be considered a liveable range of at least 235 miles (378 km). This paper is not meant to declare winners or losers. Clearly a larger, heavier and quicker car consumes more energy and requires a bigger battery, just like a gas car would need a larger gas tank. That's how this comparison should be viewed. We believe that affordable, long range EVs are a game-changer in making EVs appeal to a broader audience beyond early adopters. Clearly, Tesla models and GM's Chevrolet Bolt significantly advance the cause for EVs.

Consumer Reports is committed to providing independent, data driven, and evidence-based consumer information regarding range and charging times.

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Author

Gabriel Shenhar has been an auto-test engineer with Consumer Reports for 25 years. In his current capacity of Program Manager, Vehicle Dynamics he leads a team that tests all vehicles both on road and track. He oversees the purchasing of all test vehicles and is involved with all jury evaluations. He's been CR's point person for testing EVs since 2007 and procured CR's charging equipment. He's also a regular on CR's podcast Talking Cars. Shenhar holds a BS in Mechanical Engineering from the New Jersey Institute of Technology.