Tesla Model S driving ranges on non-urban Interstate Highways under varying conditions[1][2]

Interstate Highway speed limits (non-urban, contiguous 48 states)

12 states 65 MPH, 20 states 70 MPH,
14 states 75 MPH, 1 state 80 MPH(Texas) [3]
(source: www.ghsa.org)

Tesla Model S 85 kWh version

Range advertised by Tesla as 300 miles at 55MPH

Ideal driving conditions : no AC/heat, level terrain, 300 lbs aboard, windows rolled up, constant speed, no wind.
Sources: www.teslamotors.com, Tesla battery engineer claims

MPH	6 5	7 0	7 5	8 0 [5]
New [4]	262	241	222	200
4 1/2 yrs	243	223	205	185
9 1/2 yrs	220	203	187	168

Ideal driving conditions, but using avg AC/heat [6]

MPH	6 5	7 0	7 5	8 0 [5]
New	236	217	200	180
4 1/2 yrs	219	201	185	167
9 1/2 yrs	198	183	168	151

Assuming an additional 15% energy consumption due to non-ideal driving conditions, heavier AC/heating [7]

MPH	6 5	7 0	7 5	8 0 [5]
New	197	181	166	150
4 1/2 yrs	182	167	153	139
9 1/2 yrs	165	152	140	126

Tesla Model S 60 kWh version [8]
Range advertised by Tesla as 230 miles at 55MPH

Ideal driving conditions : no AC/heat, level terrain, 300 lbs aboard, windows rolled up, constant speed, no wind.
Sources: www.teslamotors.com, Tesla battery engineer claims

MPH	6 5	7 0	7 5	8 0 [5]
New	199	183	169	152
4 1/2 yrs	184	169	156	141
9 1/2 yrs	168	154	142	128

Ideal driving conditions, but using avg AC/heat [6]

MPH	6 5	7 0	7 5	8 0 [5]
New	179	165	152	137
4 1/2 yrs	165	153	141	127
9 1/2 yrs	151	139	128	115

Assuming an additional 15% energy consumption due to non-ideal driving conditions, heavier AC/heating [6]

MPH	6 5	7 0	7 5	8 0 [5]
New	149	137	127	114
4 1/2 yrs	138	127	117	106
9 1/2 yrs	126	115	106	96

Tesla Model S 40 kWh version [8]

Range advertised by Tesla as 160 miles, at 55MPH

Ideal driving conditions : no AC/heat, level terrain, 300 lbs aboard, windows rolled up, constant speed, no wind.
Sources: www.teslamotors.com, Tesla battery engineer claims

MPH	6 5	7 0	7 5	8 0 [5]
New	139	128	118	106
4 1/2 yrs	129	118	109	98
9 1/2 yrs	117	107	99	89

Ideal driving conditions, but using avg AC/heat [6]

MPH	6 5	7 0	7 5	8 0 [5]
New	125	115	106	95
4 1/2 yrs	116	106	98	89
9 1/2 yrs	105	96	89	80

Assuming an additional 15% energy consumption due to non-ideal driving conditions, heavier AC/heating [7]

MPH	6 5	7 0	7 5	8 0 [5]
New	104	96	88	79
4 1/2 yrs	97	88	82	73
9 1/2 yrs	88	80	74	67

Notes:

[1] These ranges indicates the distance at which the vehicle can travel no further. The actual, obtained range will be less than that. It will depend upon where the next charging station is located, closest to the end of range. For example, if Tesla supercharging stations are located 40 miles apart, then, on average, the actual obtained range will be reduced by half that distance, being 20 miles less than what's indicated in the table. But it could be as much as 38 miles less than the maximum range under those circumstances.

[2] Changes in range as a function of time reflect yearly losses in battery capacity of 1.66% per year. Loss percentages based on figures reportedly provided by a Tesla battery engineer in a forum as "[attempting to get]30% in 18 years," and from a published graph, which indicated 15% in 9 years. Whether these represent ideal deterioration rates I do not know. But apparently battery deterioration is not only a function of time : driving style, owner charging habits and other factors can have an effect. Thus, the deterioration effects displayed in these tables may represent a best case scenario.

[3] The states with the higher Interstate limits are generally large and usually have fairly level road terrain. Those states that have 65 mph limits are usually small states, mostly clustered in New England, with significant hilly terrain. Texas, with 80 mph limits, has more Interstate road mileage than New York, New Jersey and all of the New England states combined. Delaware has no Interstate highways.

[4] The "NEW" row figures for ideal conditions, 85kWh version, no AC/heat, were

eyeball estimates of data provided by graphs on Tesla Motors' own website (displayed below). I believe them to be close, but are unlikely to represent the exact figures being displayed in graphical format.

[5] 80 MPH estimates are included due to the existing reality that a large number of vehicles travel the Interstates at this velocity, especially where the posted limits are 70 or 75 MPH, and in recognition that Texas, which has an 80 mph limit, has extensive non-urban Interstate Highway mileage : more than the Northeastern states of New York, New Jersey, Delaware, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire and Maine, combined.

[6] AC/heat penalties claimed to be 5 - 10% by a Tesla executive. Tesla's website has published a graph plotting energy requiremnts for "HVAC" per mile as a function of vehicle speed. This is apparently for a generic vehicle, not specifically the Model S. It shows the energy requirements for HVAC as 10.5% at 65mph (on a per mile basis) and growing as speeds increase (the wind chill effect). While it would be expected that the total HVAC penalty while driving at higher speeds would be proportionally less, due to shorter driving times, HVAC energy consumption rates actually increase as speeds increase, negating that effect. I have no precise data that would enable precise estimates of the HVAC effect at the speeds we are dealing with here, but believe that assuming a 10% penalty for all speeds covered is a fairly reasonable assumption, although it seems likely to be an underestimate.

Of course, the HVAC consumption rates used represent single point data, presumably an average of energy requirements over the course of a period of time, locale unknown, which we will label as "average AC/heating." Obviously there will be many instances when HVAC penalties will significantly exceed those average penalties : these we as "heavier AC/heat," and are reflected in the third tables, among other penalizing effects.

There are also the effects to be expected due to the number of passengers aboard : more passengers will decrease the load on the heating system but increase the HVAC load while cooling.

The data in the tables assume that the car is being driven continuously at a fairly consistent speed (most likely using cruise control). However, traffic accidents do occur (as well as backups) , accompanied by long periods in which the vehicle is more or less stationary. If cooling or heating is required during these periods then obviously it can affect the car's driving range in a negative fashion, the extent to which would require data on such energy consumption as a function of time. Such data is not currently available. The data presented in these tables assumes nothing other than continuous driving at the posted limits, with no range-penalizing stoppages.

[7] The second tables for each version represent ideal driving conditions to achieve maximum range but using average AC/heating. Obviously it will be a fairly common occurance that heavy use of AC or heating is required, which will further reduce driving ranges. Other common and significant penalties will be extracted due to rainy and wet conditions. During those periods there are several possible negative effects: increased HVAC usage to maintain clear windshields, wiper motor operation, exterior lighting, including fog lamps, greater aero effects due to presence of water in the atmosphere, and increased tire rolling resistance due to wet roads. Only the aero and HVAC effects increase with speed. The others would be mostly a function of time (at a constant given speed), and thus would extract a greater range penalty at slower speeds. After doing some calculations, it appears as though these would

amount, proportionally, to roughly a 30% greater penalty, for the 65mph car than the car traveling at 80mph.

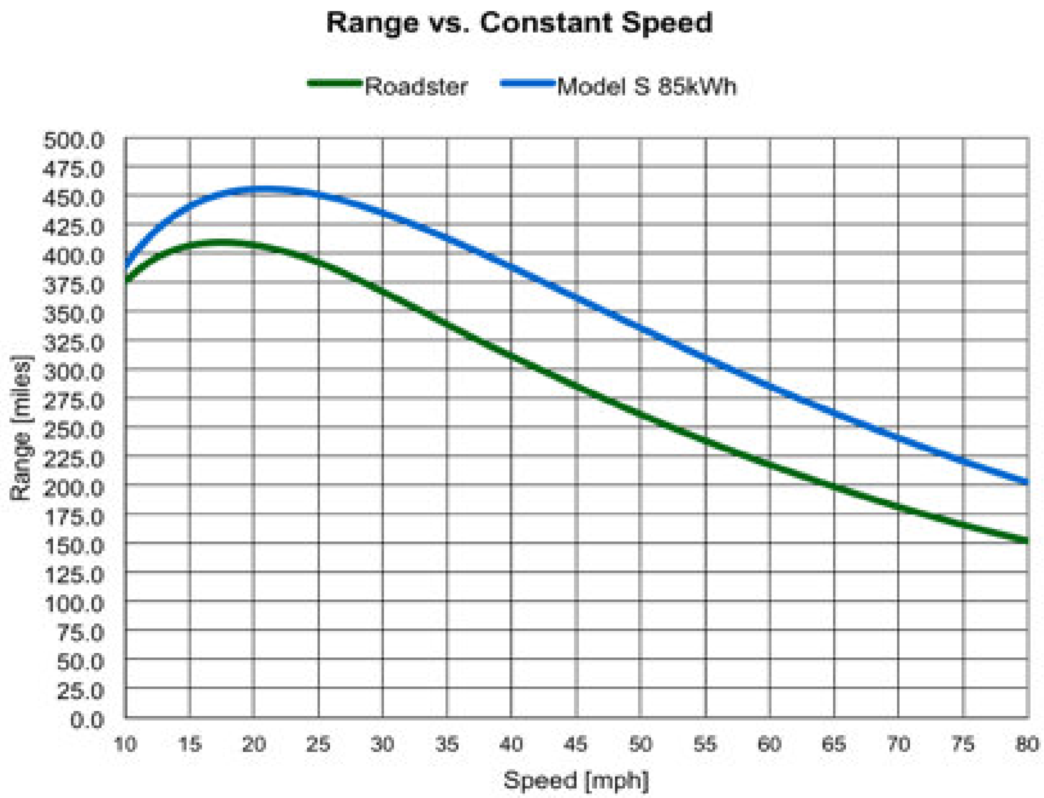
Additional passenger load and cargo both increases weight and the energy required to cool the interior. Headwinds can have a significant effect – a 10 mph headwind is equivalent to driving 10 mph faster so far as the penalties of aerodynamic drag are concerned, which dominate total energy consumption as speeds reach the levels found on our Interstates. Driving on non-level terrain will certainly have a negative effect on range. Improper tire pressures can also have a significant effect.

The third tables include penalties beyond the "average" AC/heating penalties reflected in the second tables. A 15% additional penalty, for all speeds, was chosen, despite the fact that the same negative conditions will sometimes exert a somewhat greater penalty on slower travelers.

Although I have no data to substantiate, I suspect that the third table does not represent a worst case scenario, hypothetical though it may be.

[8] Data for 40 and 60 kWh versions was an extrapolation of those provided by Tesla Motors for the 85 kWh version, based on their claimed 160 and 230 mile ranges. The only likely differences between the three vehicles with respect to range as a function of speed would only occur due to the only obvious difference between the three versions : the weight of the battery pack. The data from Tesla for those versions (160,230 miles) accounts for any weight differences in their stated ranges at 55 mph, and I deem it unlikely that the heavier version would exhibit significantly different range performance characteristics as a function of increases in velocity (i.e. the range curves of all three cars would have the same shape).

Graphic display ranges of Tesla Model S and Roadster as a function of speed
(constant speed, no AC, no heating, 300 pounds aboard, windows up, level terrain)
source: www.teslamotors.com



Graphic display sources of energy consumption in an automobile : from www.teslamotors.com