Program version: V12

These plotted curves show, from various perspectives, the battery range of a
2018 Tesla Model 3 LR RWD.

The data for these was obtained by driving the car back and forth on a fairly flat road
multiple times, at different speeds, and recording the energy usage per distance as shown
by the car in watt-hours per unit distance travelled. This data is shown on one of the plots.
Also, certain data was found on the internet, such as vehicle weight.

Many plots show curves for a much wider range of speeds than those used in the testing
described above. This was done by fitting a 3rd-order polynomial to the power curve obtained
from the testing. From that polynomial power curve, the coefficients of rolling resistance
and drag and the baseline power were estimated. From those, the rolling power and drag power
were estimated for speeds from near 0 to quite fast. The total power is then the sum of the
baseline power, rolling power and drag power. Finally, that total power estimate at different
speeds is used to compute the curves for most of the plots.

Some plots take into account battery degradation. This was obtained for the car described
above as follows: Ran Tesla battery test in hidden service menu.

If you would like curves plotted for another car and can provide the necessary energy data,
contact me and we'll see if we can arrange it.

If you have questions or concerns about any of the plots, you can contact me on various
online groups or at ted@tedtoal.net

The R code used to produce these plots is available on GitHub at:
https://github.com/tedtoal/EV-battery-and-range-plots

The author, Ted Toal, can be contacted via email at ted@tedtoal.net

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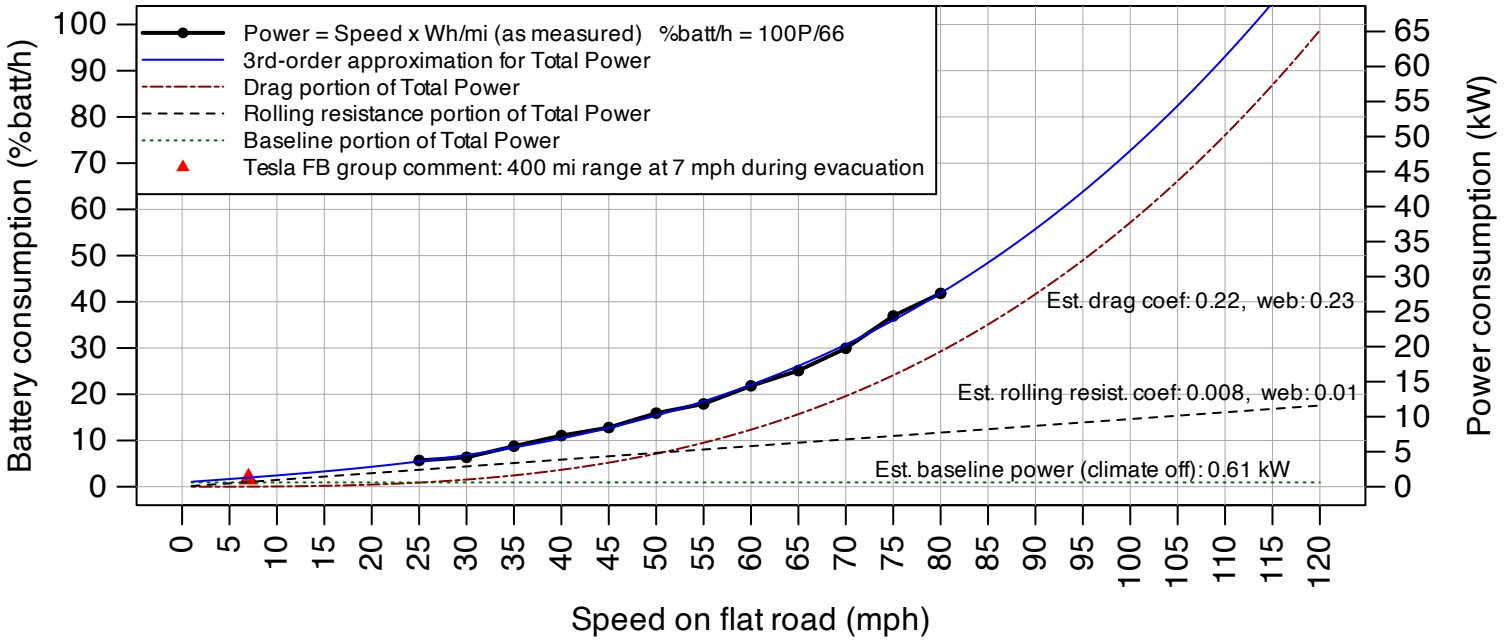
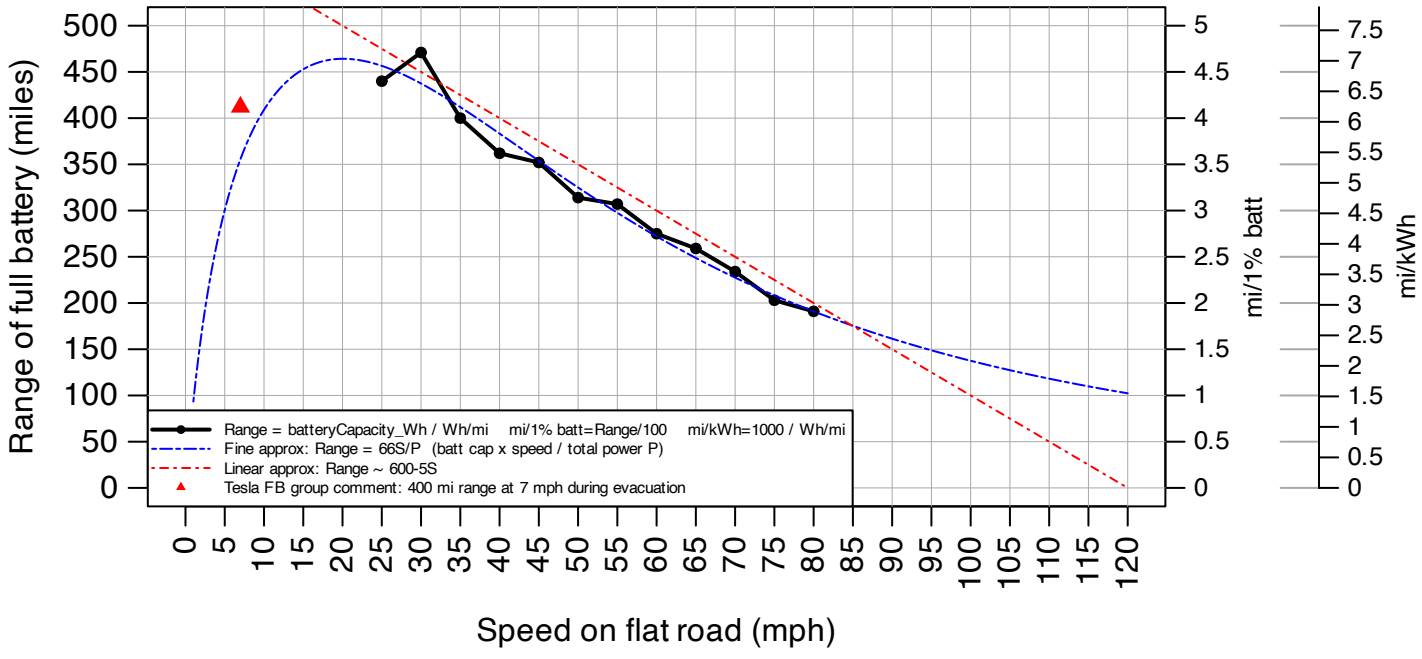
Power consumption and estimates of rolling and drag coefficients

This shows points computed from raw data and a 3rd-order approximation.
Assumptions: A: 2018 Tesla Model 3 LR RWD B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: batt degraded 12% for 66kWh capacity D: 100% SOC is 66kWh
E: 3rd-order approx for Total Power ~ .0000376S^3 + .096S + .61 (S = speed)
F: Est. Rolling Coef ~ 1000 x speed_coef x convert_mps_to_xxph x eff / vehicleWeight_N
G: Est. Drag Coef ~ 1000 x speed_cubed_coef x convert_mps_to_xxph^3 x 2 x eff / air_density / frontal_area
H: Est. Baseline Power ~ constant_term_coef I: Est. Total Power P = baseline+rolling+drag power
J: Rolling Power = S x coefRolling x vehicleWeight_N / eff / 1000 (S=speed, mps)
K: Drag Power = SC x SA^2 x coefDrag x airDens x area x (SA>=0? 1/eff : -regenEff) / 2000 (SC=car, SA=air speeds, mps)



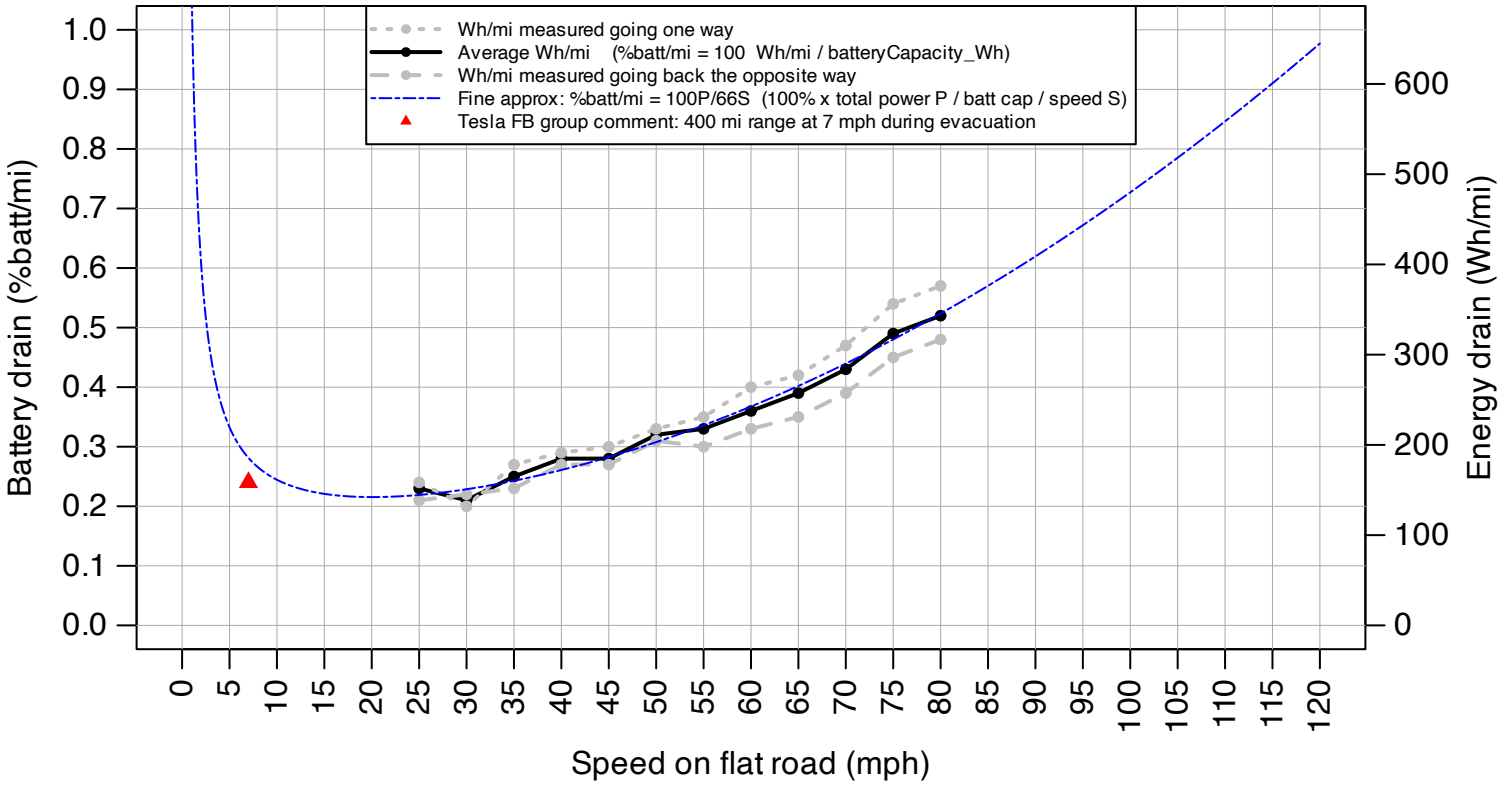
Estimated range at various speeds

This shows points computed from raw data, and includes linear and derived approximations.
Assumptions: A: 2018 Tesla Model 3 LR RWD B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: batt degraded 12% for 66kWh capacity D: 100% SOC is 66kWh
E: Est. Total Power P = baseline+rolling+drag power



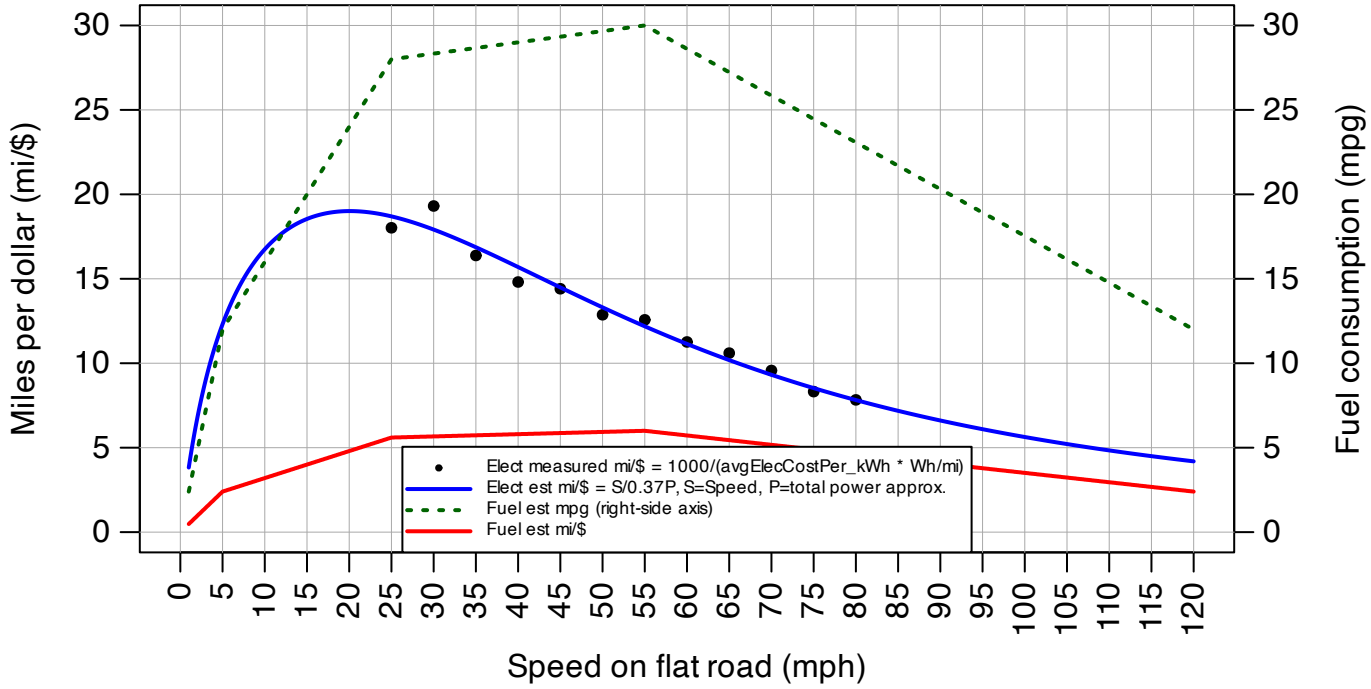
Energy used per mile at various speeds

This shows raw (measured) data and an approximation curve.
Assumptions: A: 2018 Tesla Model 3 LR RWD B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: batt degraded 12% for 66kWh capacity D: 100% SOC is 66kWh
E: Est. Total Power P = baseline+rolling+drag power



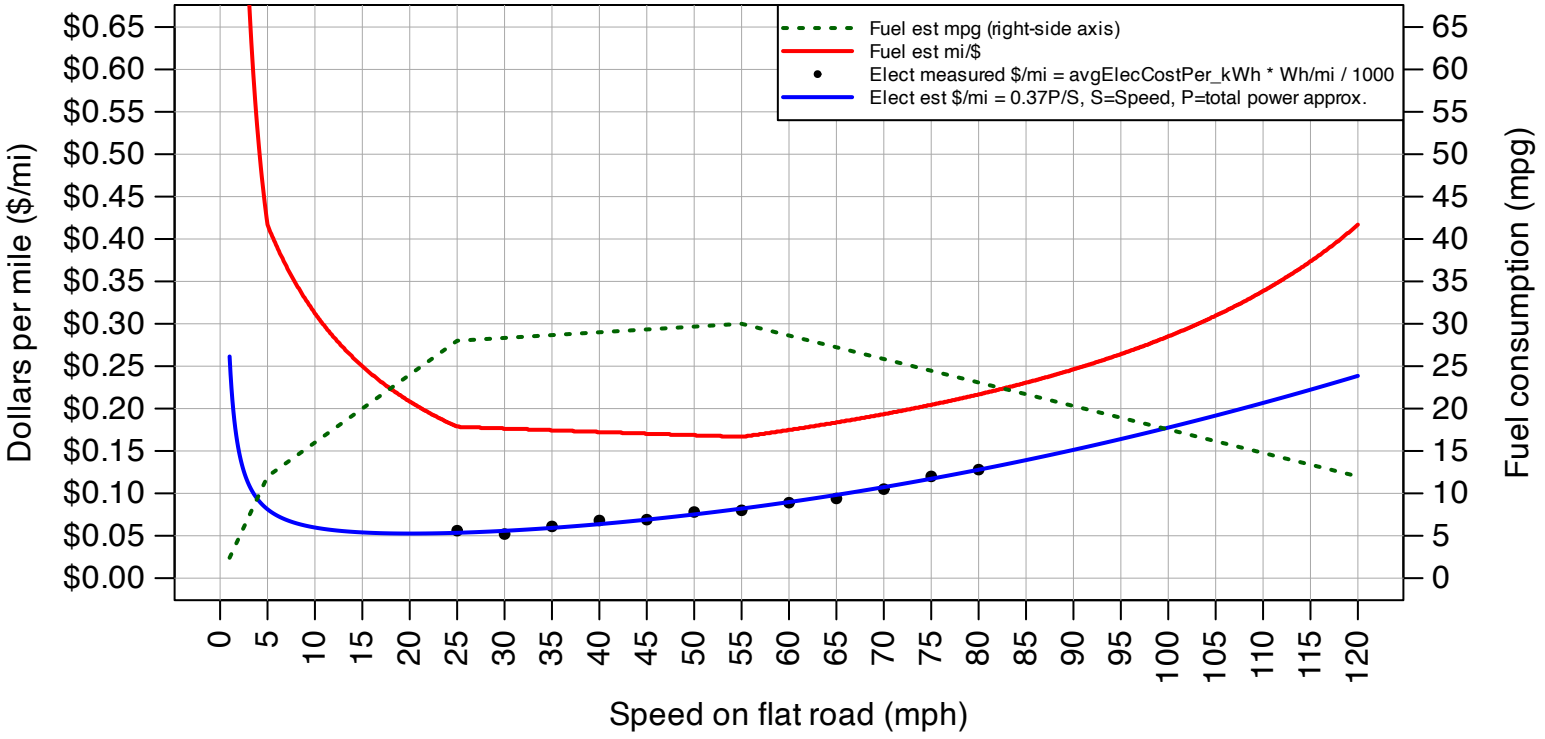
Miles per dollar at various speeds compared to fuel vehicle

Assumptions: A: 2018 Tesla Model 3 LR RWD B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: batt degraded 12% for 66kWh capacity D: 100% SOC is 66kWh
E: electricity cost $0.37/kWh (charging eff. excl.) F: fuel cost $5/gal
G: fuel efficiency as shown by dotted line with right-axis scale
H: Est. Total Power P = baseline+rolling+drag power



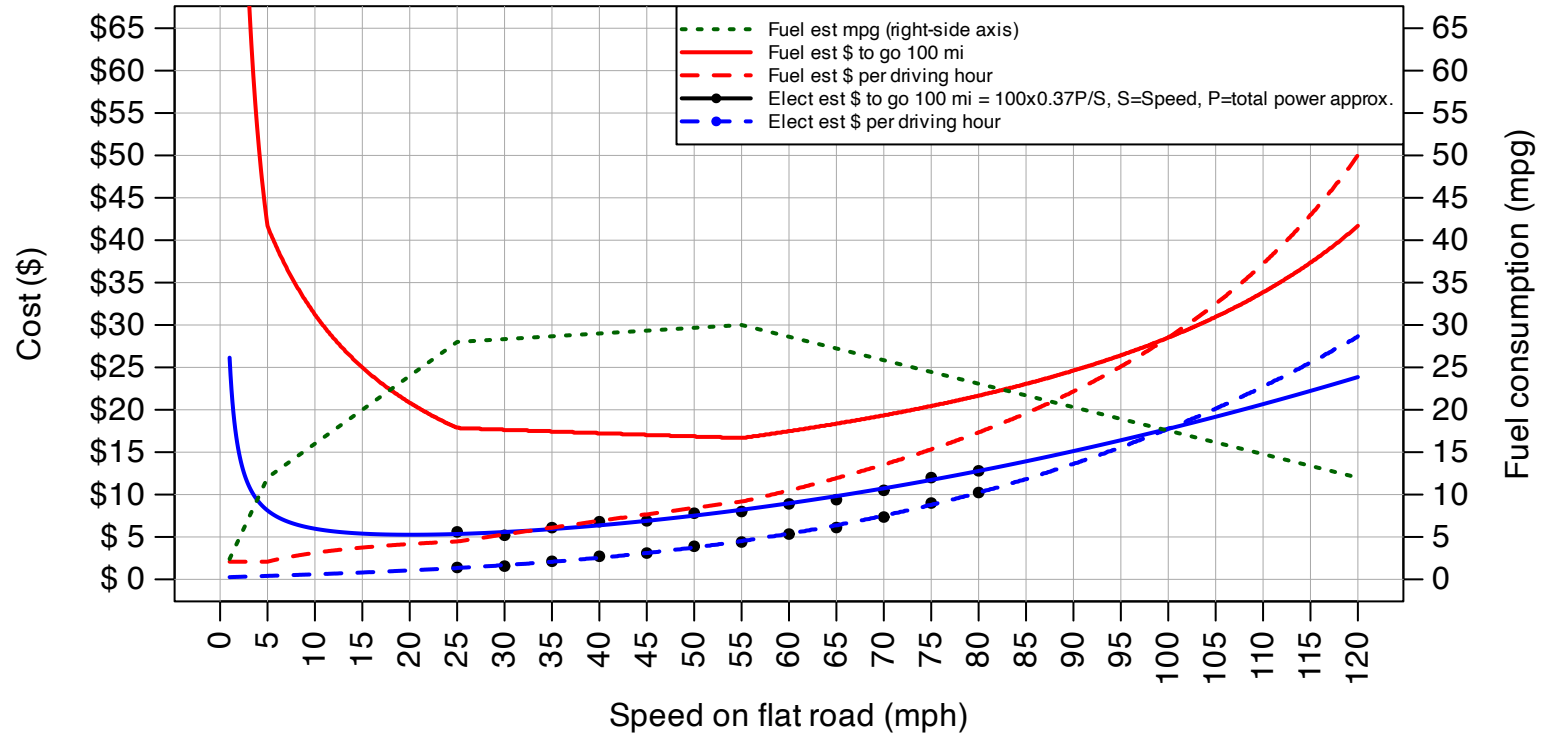
Dollars per mile at various speeds compared to fuel vehicle

Assumptions: A: 2018 Tesla Model 3 LR RWD B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: batt degraded 12% for 66kWh capacity D: 100% SOC is 66kWh
E: electricity cost $0.37/kWh (charging eff. excl.) F: fuel cost $5/gal
G: fuel efficiency as shown by dotted line with right-axis scale
H: Est. Total Power P = baseline+rolling+drag power



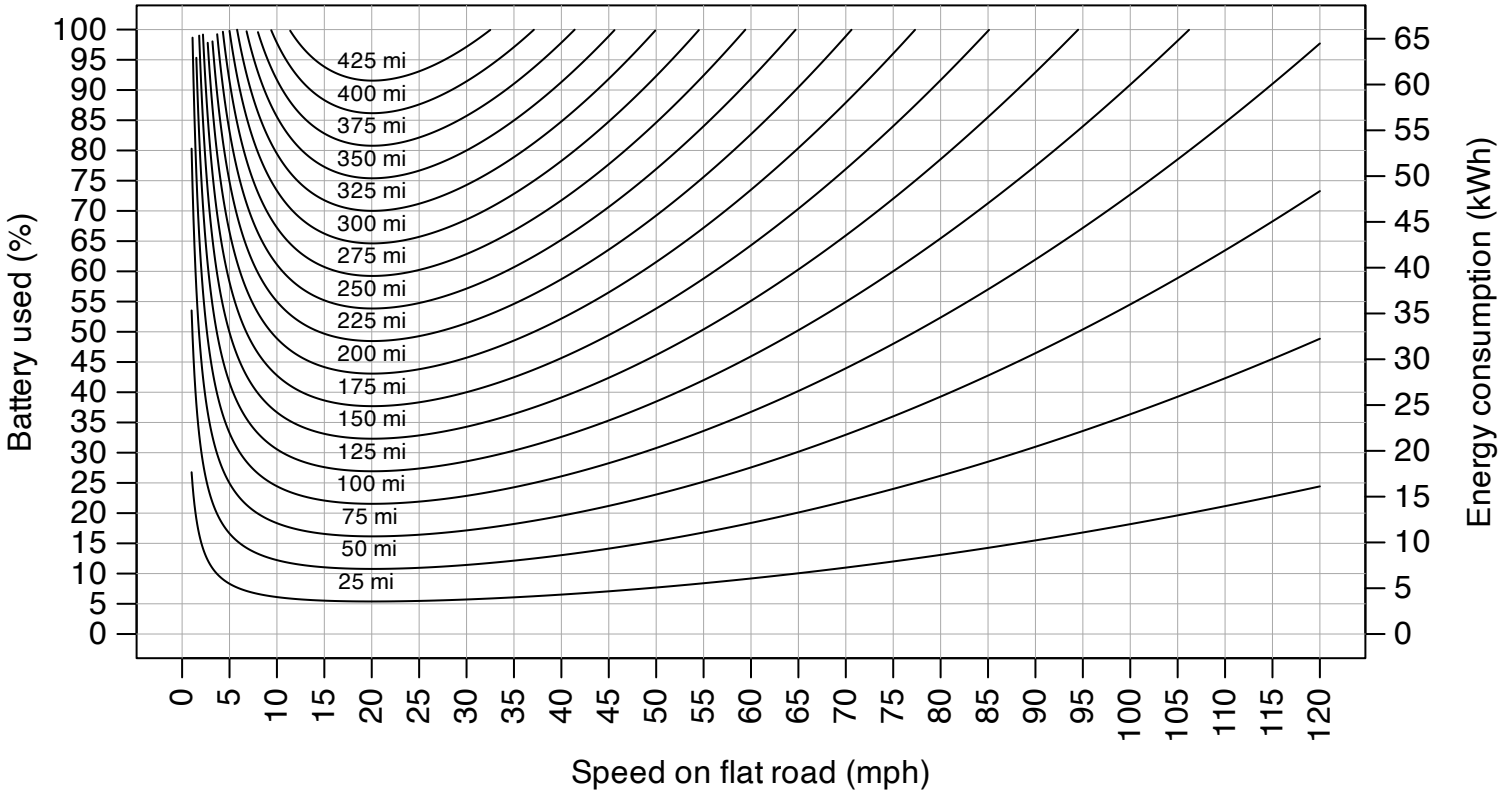
Cost in dollars per 100 mi or driving hour at various speeds compared to fuel vehicle

Assumptions: A: 2018 Tesla Model 3 LR RWD B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: batt degraded 12% for 66kWh capacity D: 100% SOC is 66kWh
E: electricity cost $0.37/kWh (charging eff. excl.) F: fuel cost $5/gal
G: fuel efficiency as shown by dotted line with right-axis scale
H: Est. Total Power P = baseline+rolling+drag power



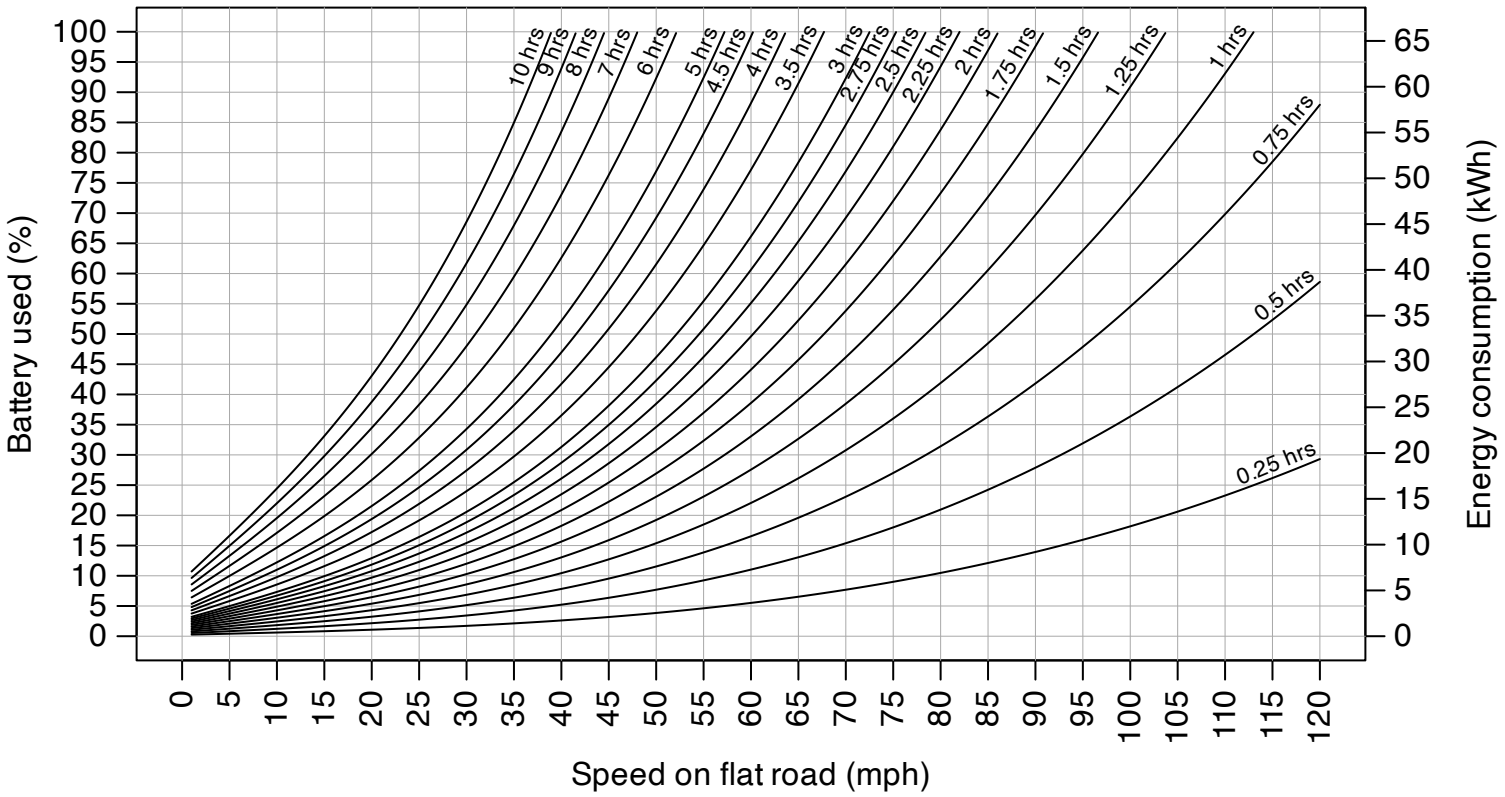
Energy used at various speeds and distances

Assumptions: A: batt degraded 12% for 66kWh capacity B: 100% SOC is 66kWh
C: Fine approx: %batt/mi = 100P/66S
D: Est. Total Power P = baseline+rolling+drag power



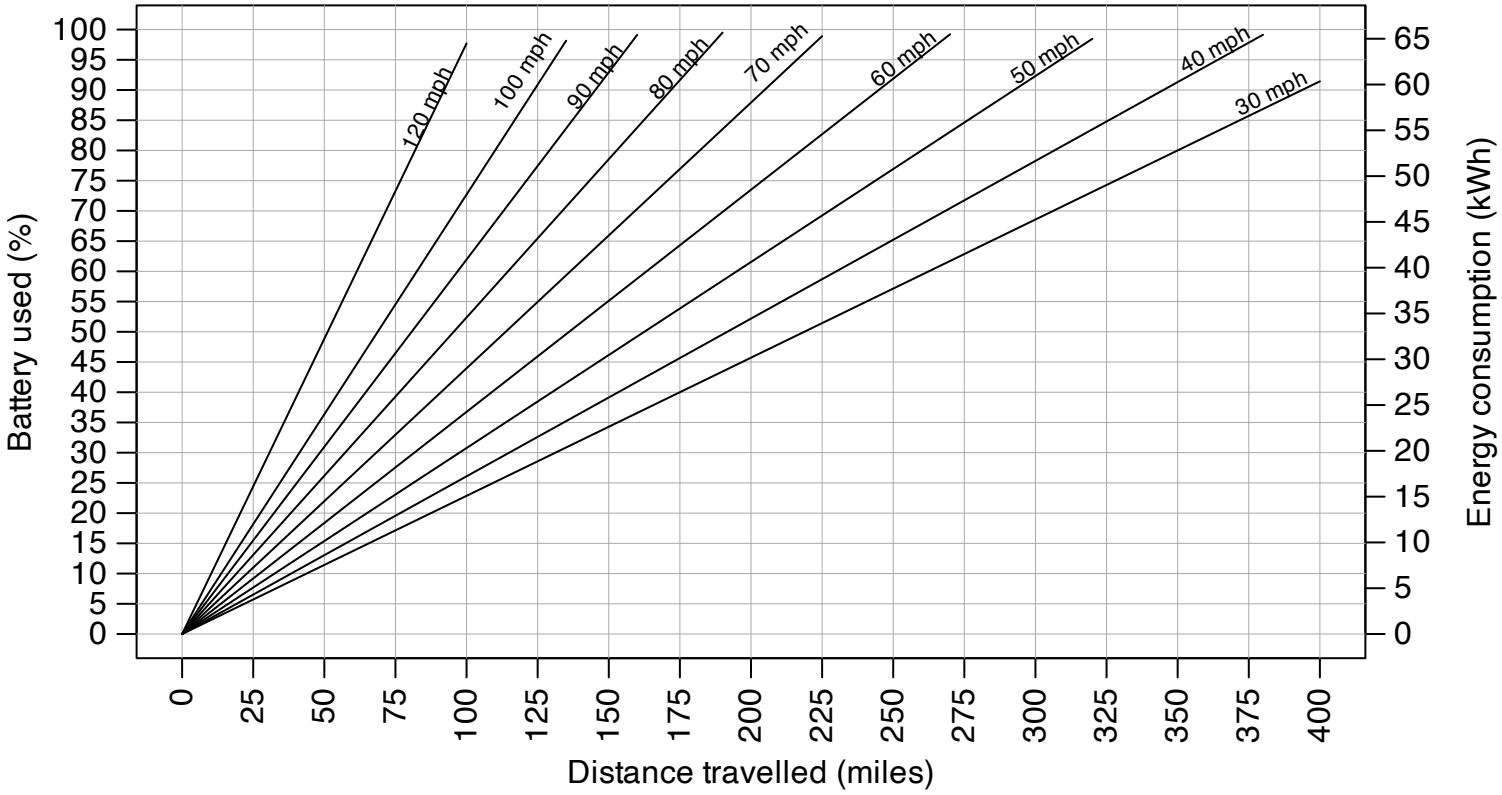
Energy used at various speeds and times

Assumptions: A: batt degraded 12% for 66kWh capacity B: 100% SOC is 66kWh
C: Fine approx: %batt/h = 100P/66
D: Est. Total Power P = baseline+rolling+drag power



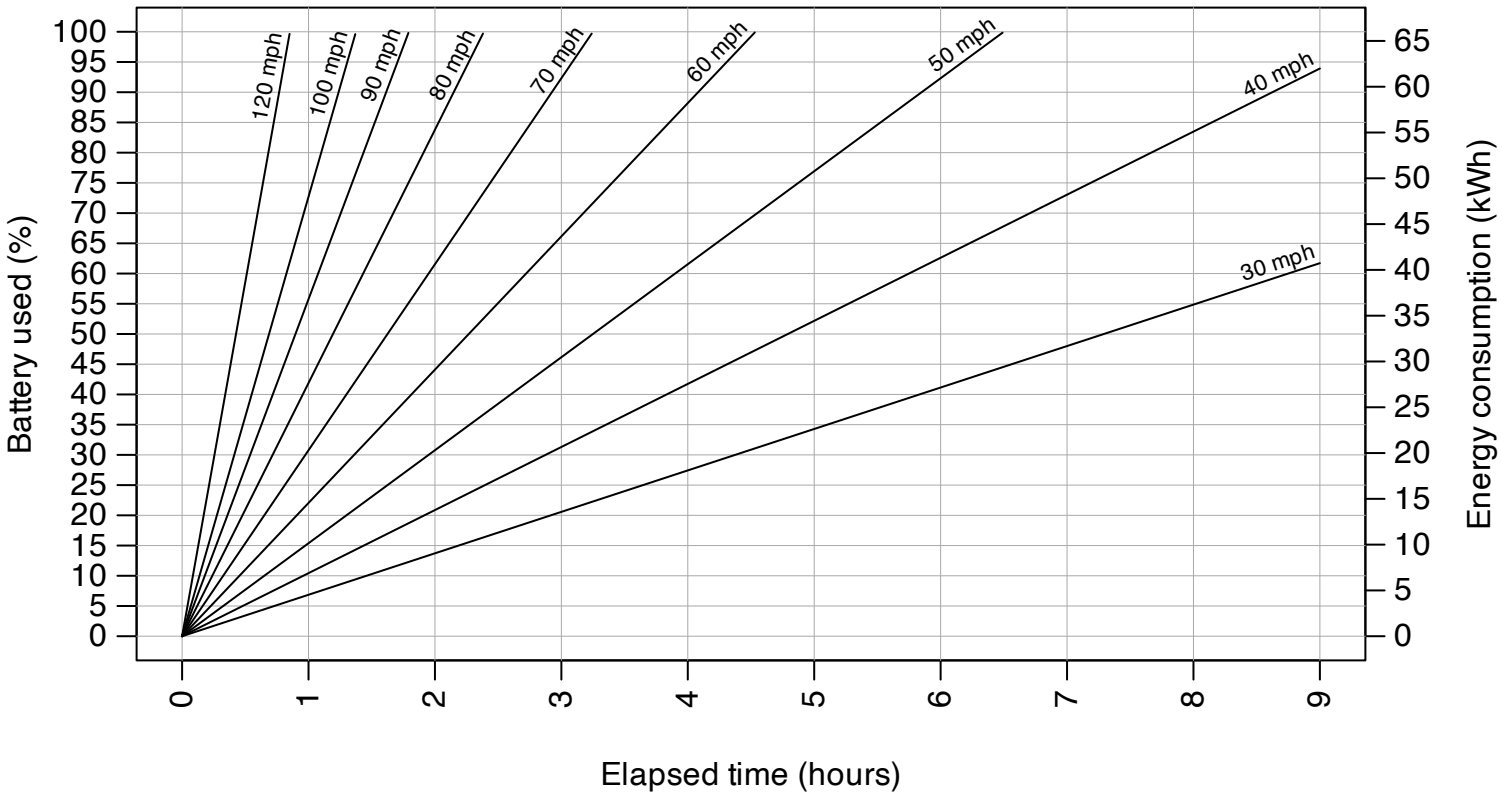
Energy used at various distances and speeds

Assumptions: A: batt degraded 12% for 66kWh capacity B: 100% SOC is 66kWh
C: Fine approx: %batt/mi = 100P/66S
D: Est. Total Power P = baseline+rolling+drag power



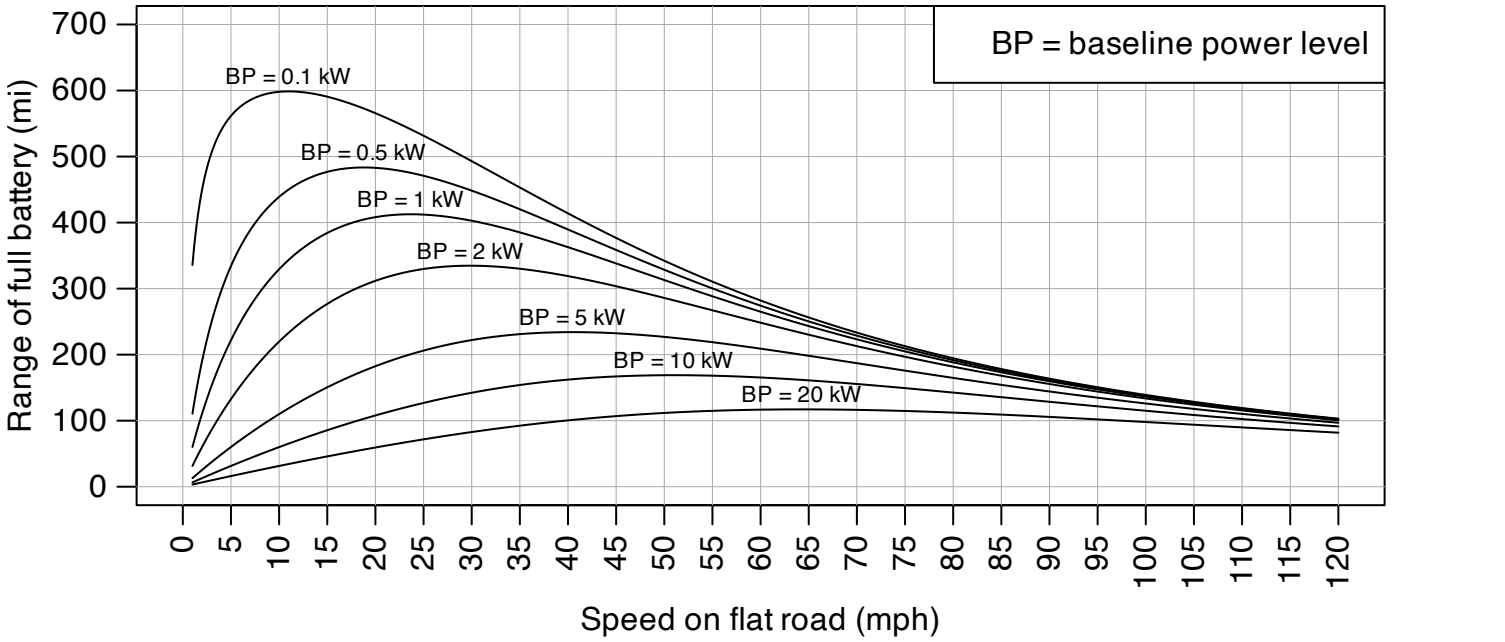
Energy used at various times and speeds

Assumptions: A: batt degraded 12% for 66kWh capacity B: 100% SOC is 66kWh
C: Fine approx: %batt/h = 100P/66
D: Est. Total Power P = baseline+rolling+drag power



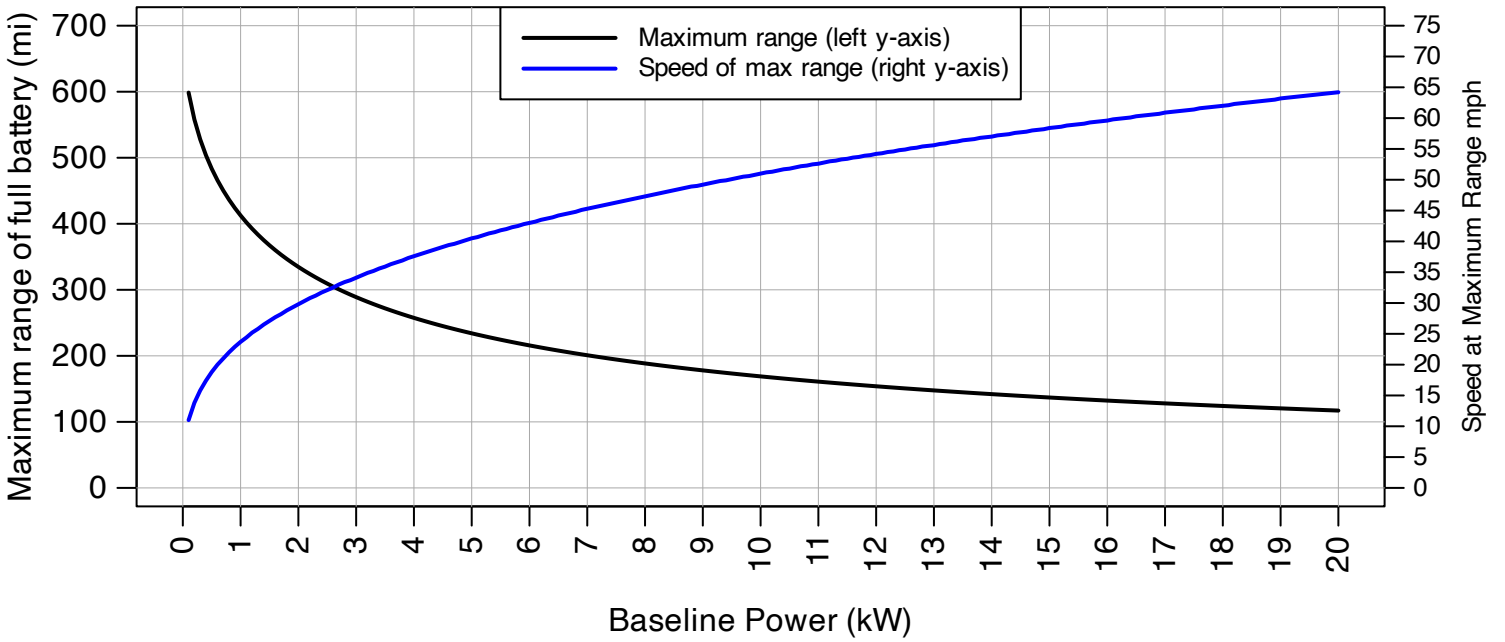
Estimated range at various speeds and baseline power levels

Assumptions: A: 2018 Tesla Model 3 LR RWD B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: weight 4250lb (with 250lb passengers) D: drag coef 0.22, roll coef 0.008
E: batt degraded 12% for 66kWh capacity F: air density computed using density altitude
G: 70% net energy efficiency upon increased load, 70% regen energy recapture efficiency
H: range = batt. cap. x speed / total power I: total power = baseline+rolling+drag power
J: Rolling Power = S x coefRolling x vehicleWeight_N / eff / 1000 (S=speed, mps)
K: Drag Power = SC x SA^2 x coefDrag x airDens x area x (SA>=0? 1/eff : -regenEff) / 2000 (SC=car, SA=air speeds, mps)



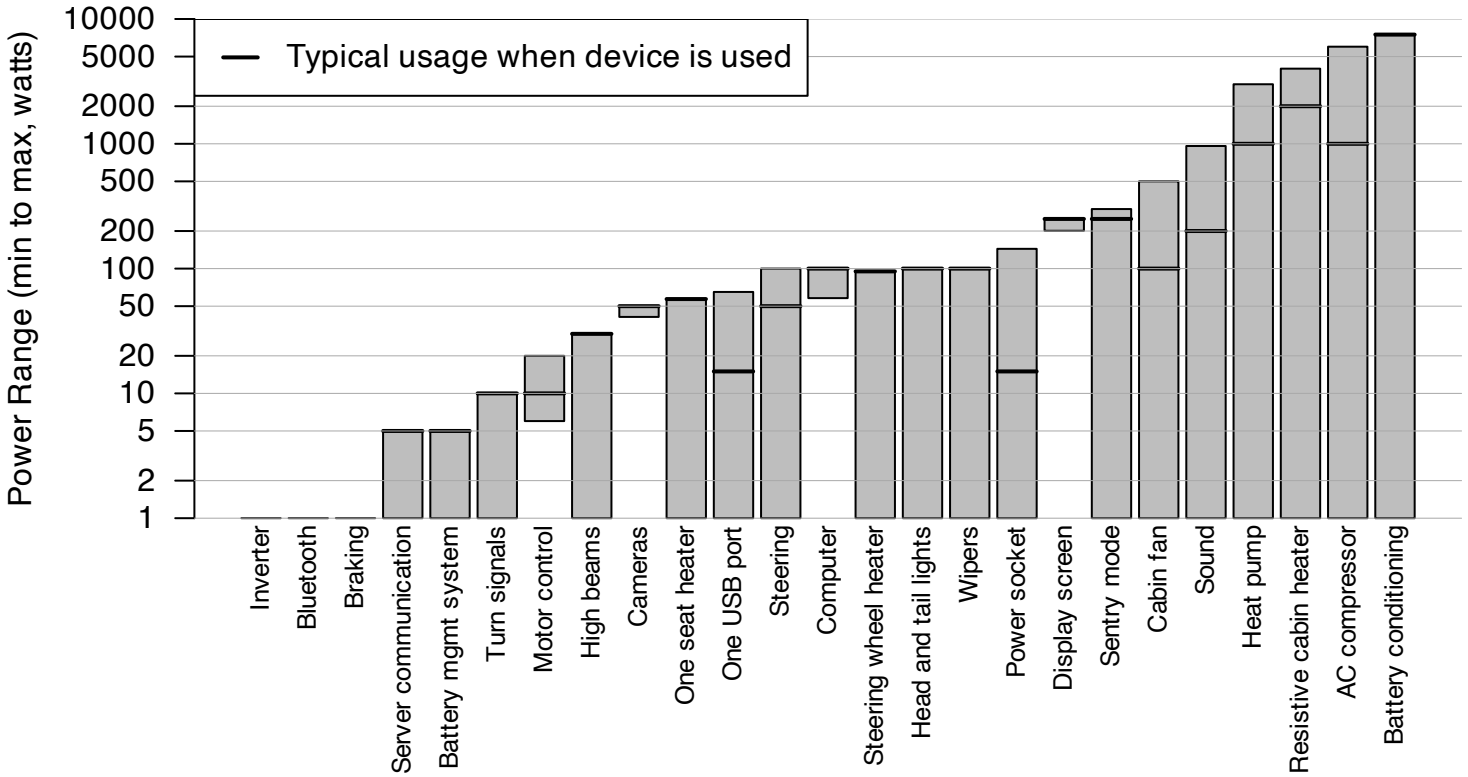
Estimated maximum range at speed with changing baseline power level

Assumptions: A: 2018 Tesla Model 3 LR RWD B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: weight 4250lb (with 250lb passengers) D: drag coef 0.22, roll coef 0.008
E: batt degraded 12% for 66kWh capacity F: air density computed using density altitude
G: 70% net energy efficiency upon increased load, 70% regen energy recapture efficiency
H: range = batt. cap. x speed / total power I: total power = baseline+rolling+drag power
J: Rolling Power = S x coefRolling x vehicleWeight_N / eff / 1000 (S=speed, mps)
K: Drag Power = SC x SA^2 x coefDrag x airDens x area x (SA>=0? 1/eff : -regenEff) / 2000 (SC=car, SA=air speeds, mps)



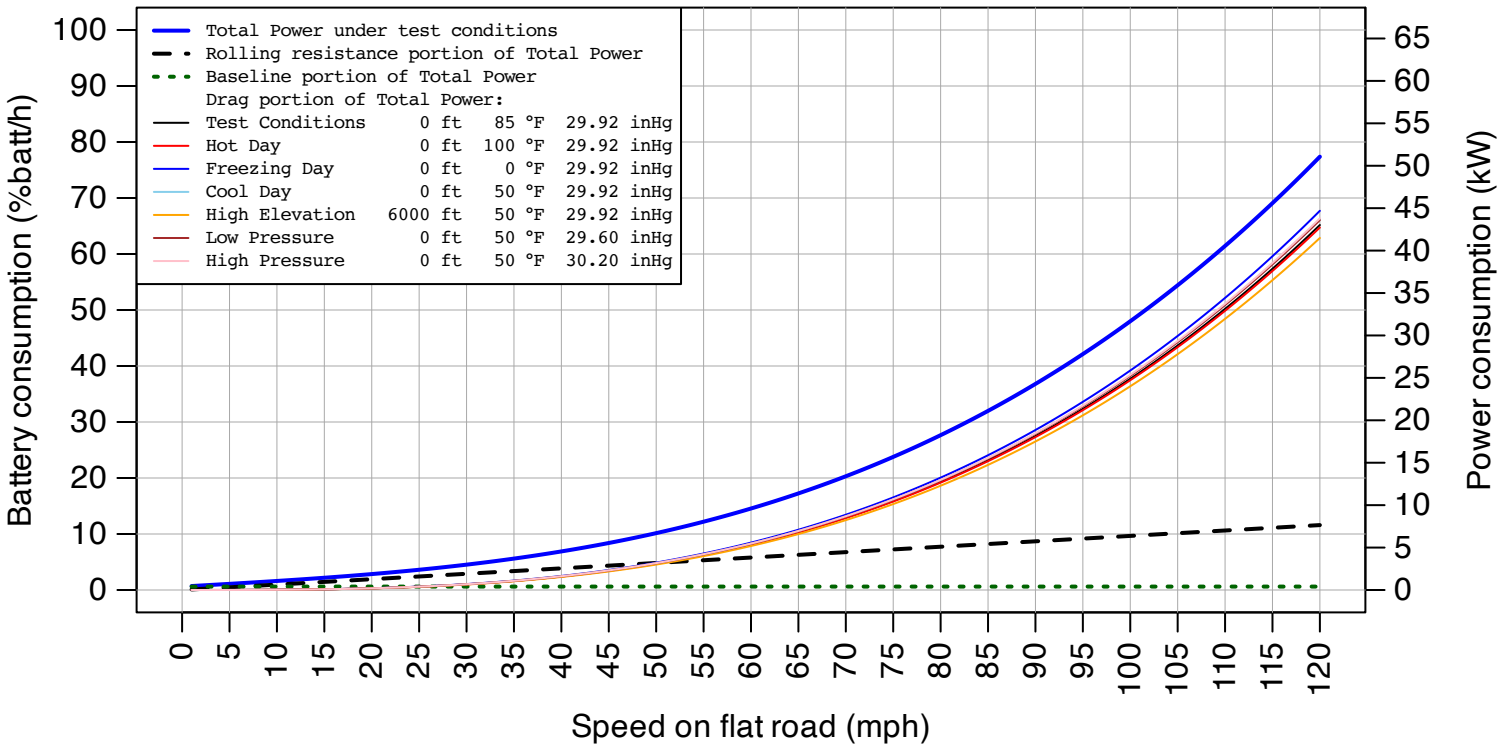
Estimated power consumption by accessories

2018 Tesla Model 3 LR RWD



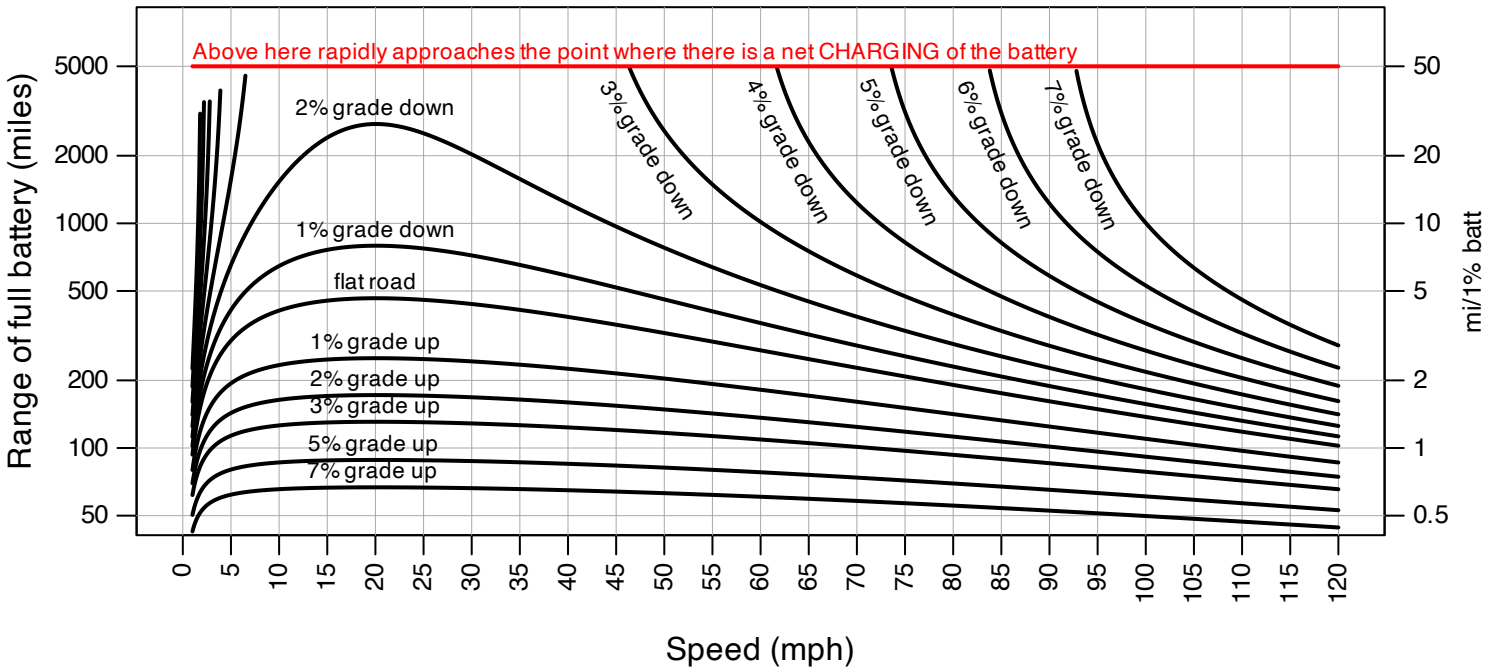
Drag battery/power consumption at various speeds

Assumptions: A: 2018 Tesla Model 3 LR RWD
B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: weight 4250lb (with 250lb passengers)
D: drag coef 0.22, roll coef 0.008, base power 0.61kW
E: frontal area 2.22sq. m.
F: air density computed using density altitude
G: batt degraded 12% for 66kWh capacity
H: 100% SOC is 66kWh
I: 70% energy eff factor applied to compute drag, rolling, and baseline power
J: Est. Total Power P = baseline+rolling+drag power (test cond)



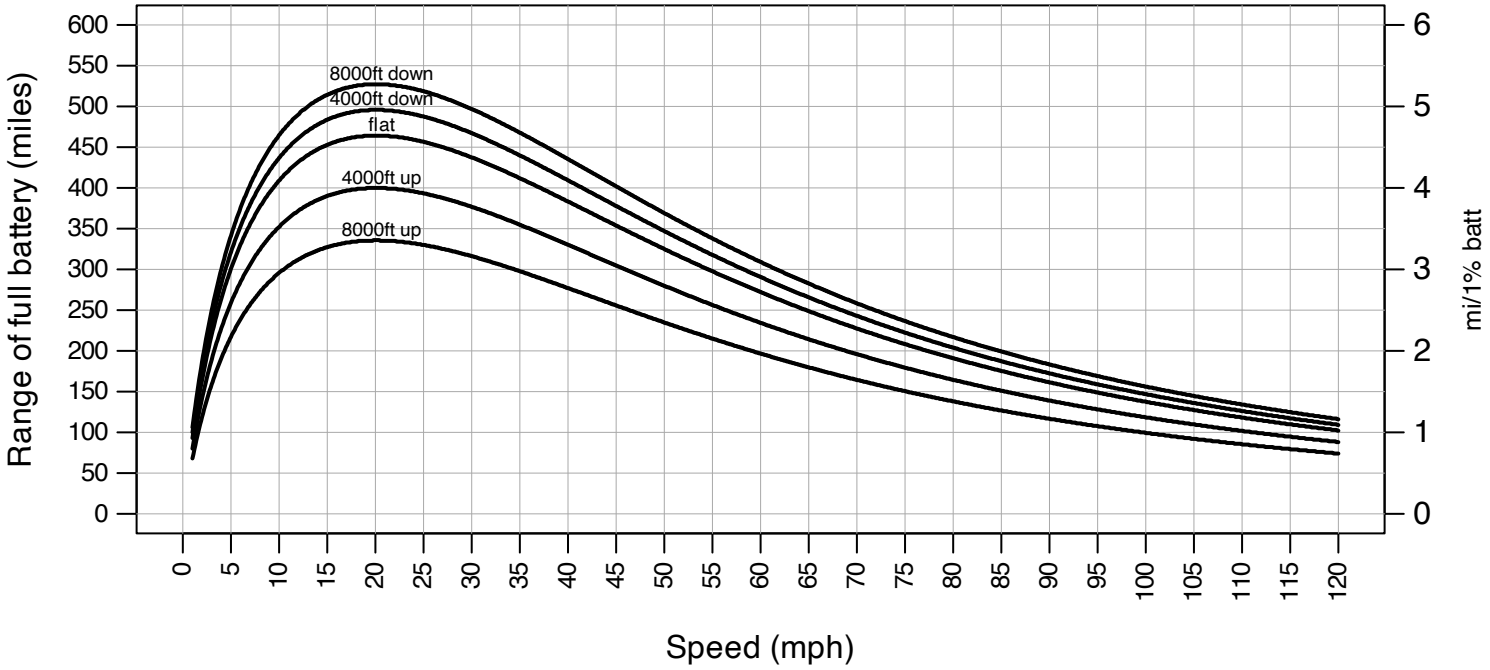
Estimated range on uphill and downhill grades at various speeds

Assumptions: A: 2018 Tesla Model 3 LR RWD
B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: weight 4250lb (with 250lb passengers)
D: batt degraded 12% for 66kWh capacity
E: 100% SOC is 66kWh
F: 70% net energy efficiency upon increased load, 70% regen energy recapture efficiency
G: Range = Speed x batteryCapacity_kWh / (Flat Road Power + Lift Power)
H: Lift Power = vehicleWeight_kg x N_per_kg x Speed_kmps x fracGrade x energyEfficiencyFactor
I: Flat Road Power = Est. Total Power P = baseline+rolling+drag power



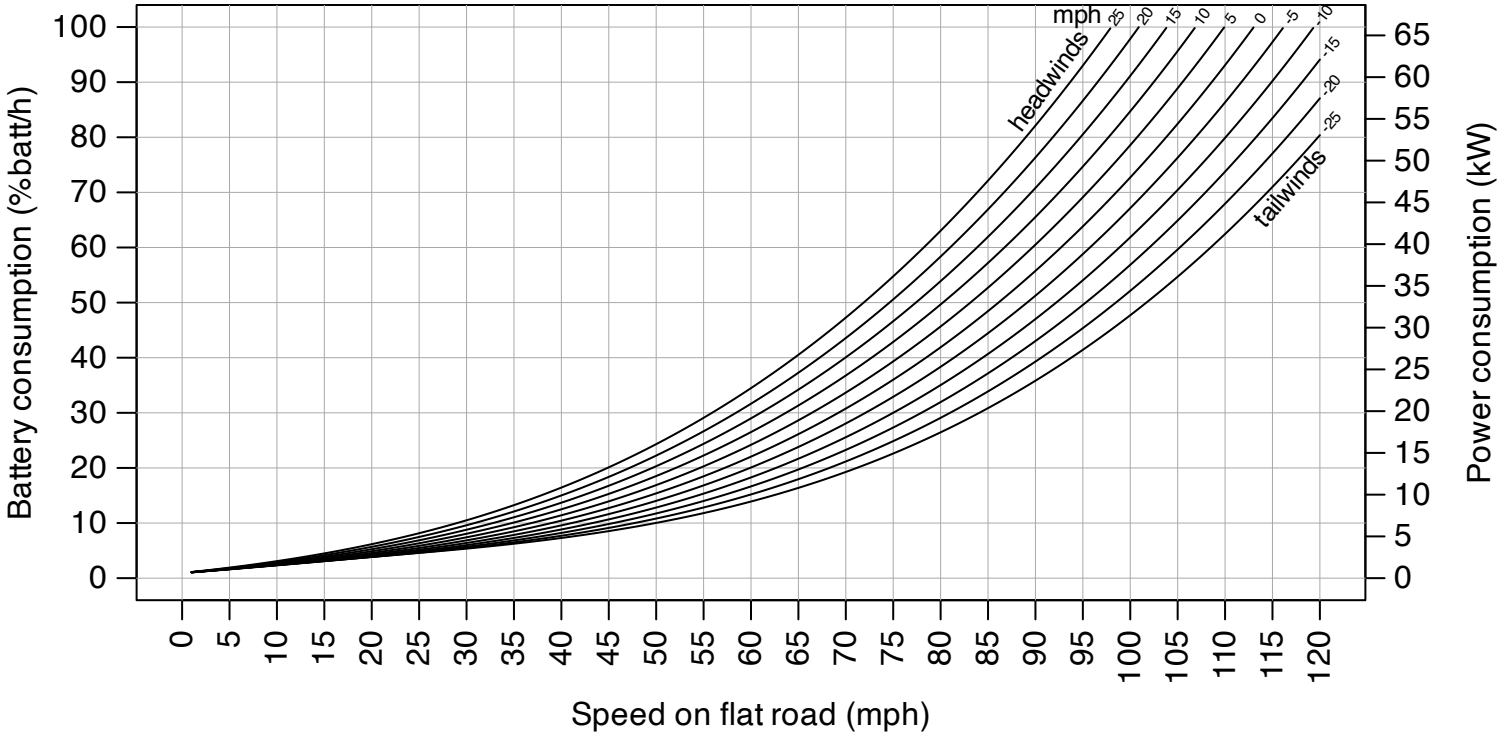
Estimated range with uphill and downhill elevation changes at various speeds

Assumptions: A: 2018 Tesla Model 3 LR RWD
B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: weight 4250lb (with 250lb passengers)
D: batt degraded 12% for 66kWh capacity
E: 100% SOC is 66kWh
F: 70% net energy efficiency upon increased load, 70% regen energy recapture efficiency
G: Range = Speed x (batteryCapacity_kWh - Lift Energy) / Flat Road Power
H: Lift Energy = vehicleWeight_kg x N_per_kg x ElevChg_m x kWh_per_Nm x energyEfficiencyFactor
I: Flat Road Power = Est. Total Power P = baseline+rolling+drag power



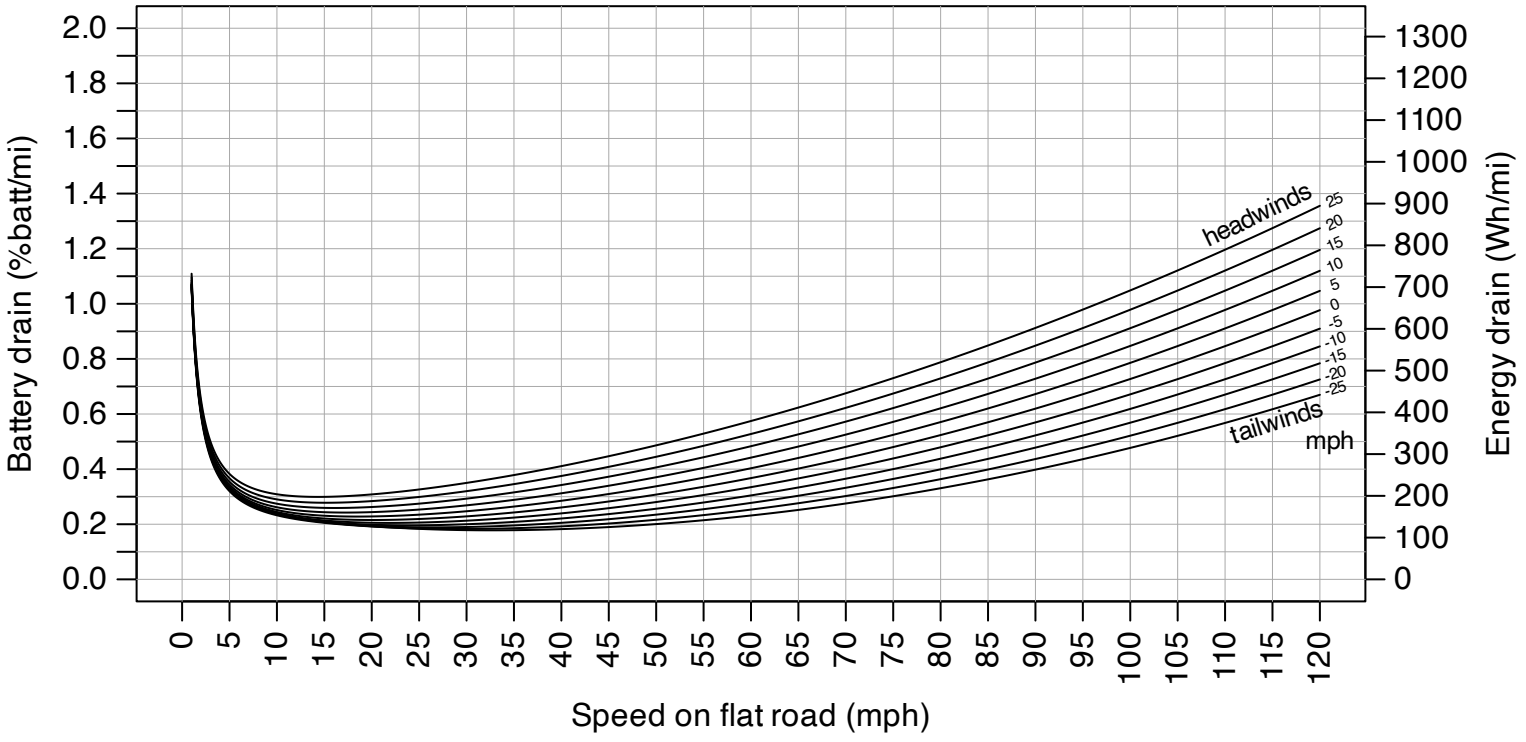
Power consumption at various car and wind speeds

Assumptions: A: 2018 Tesla Model 3 LR RWD
B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: weight 4250lb (with 250lb passengers)
D: drag coef 0.22, roll coef 0.008, base power 0.61kW
E: batt degraded 12% for 66kWh capacity
F: air density computed using density altitude
G: 70% net energy efficiency upon increased load, 70% regen energy recapture efficiency
H: Est. Total Power P = baseline+rolling+drag power (flat road)



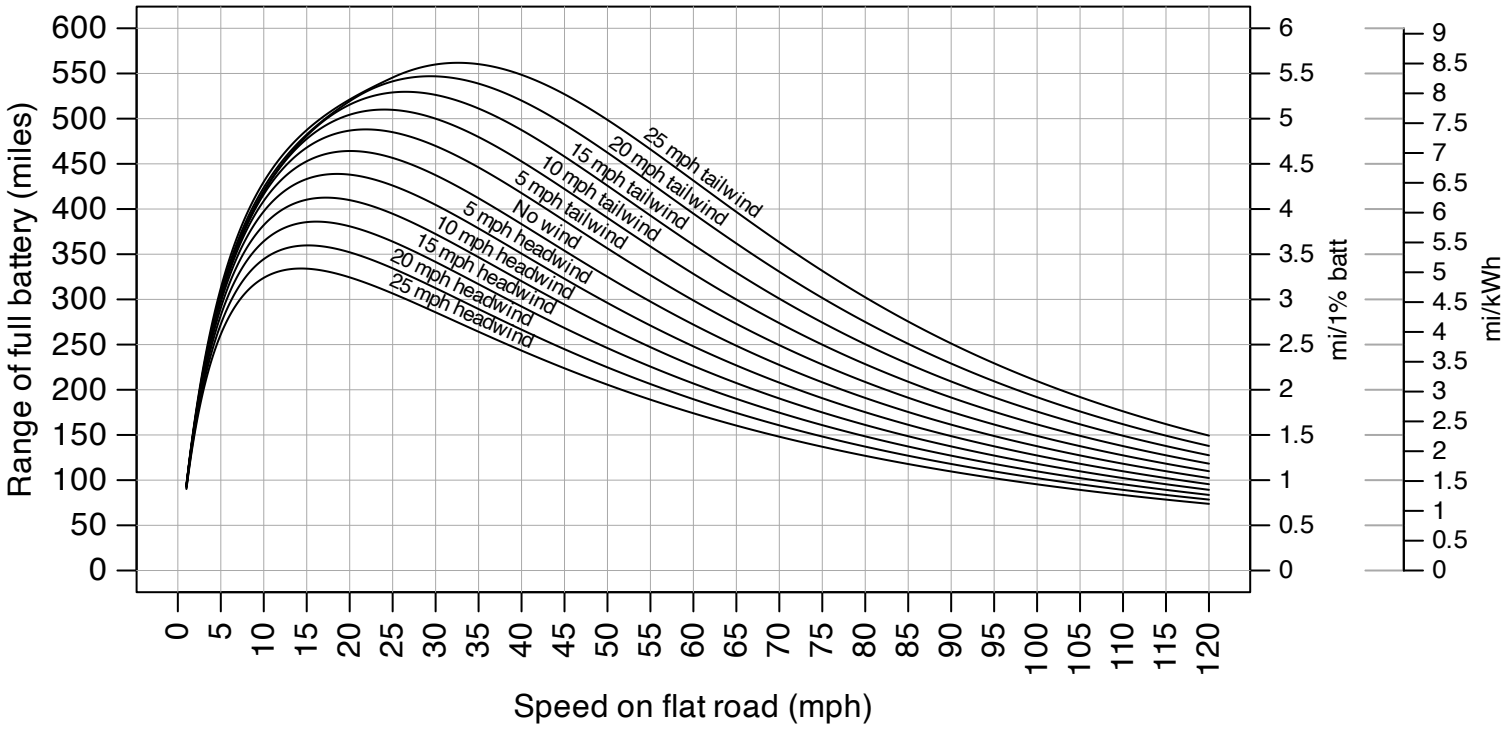
Energy used per mile at various car and wind speeds

Assumptions: A: 2018 Tesla Model 3 LR RWD
B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: weight 4250lb (with 250lb passengers)
D: drag coef 0.22, roll coef 0.008, base power 0.61kW
E: batt degraded 12% for 66kWh capacity
F: air density computed using density altitude
G: 70% net energy efficiency upon increased load, 70% regen energy recapture efficiency
H: Est. Total Power P = baseline+rolling+drag power (flat road)

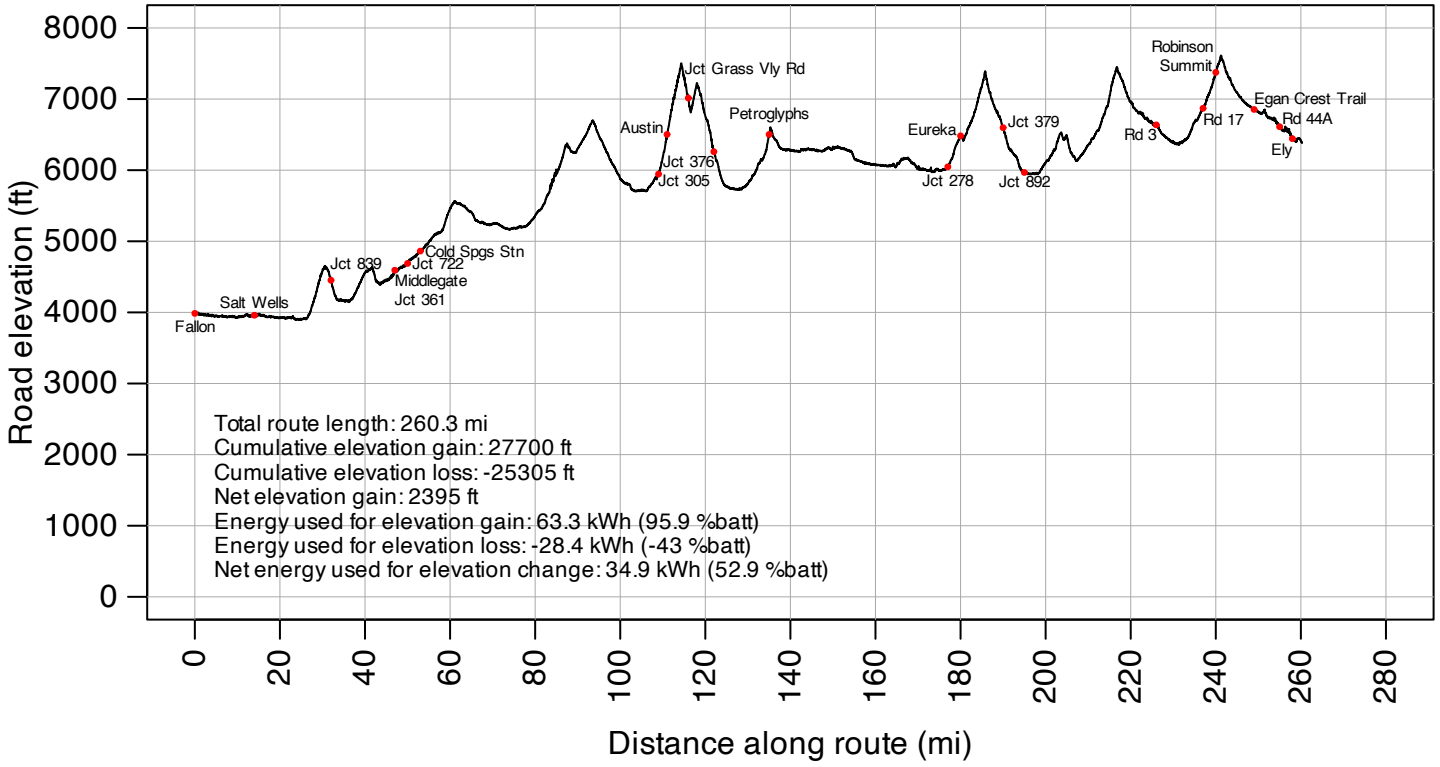


Estimated range at various car and wind speeds

Assumptions: A: 2018 Tesla Model 3 LR RWD
B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: weight 4250lb (with 250lb passengers)
D: drag coef 0.22, roll coef 0.008, base power 0.61kW
E: batt degraded 12% for 66kWh capacity
F: air density computed using density altitude
G: 70% net energy efficiency upon increased load, 70% regen energy recapture efficiency
H: Est. Total Power P = baseline+rolling+drag power (flat road)

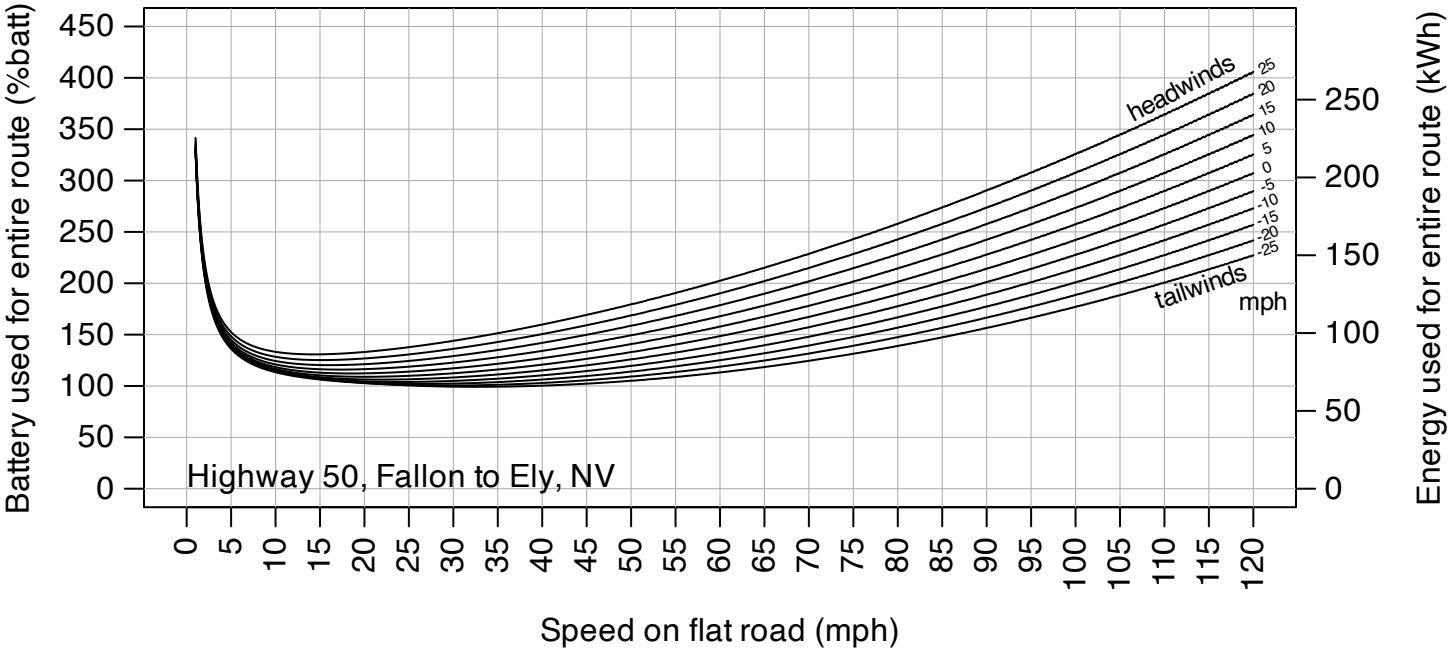


Elevation profile of Highway 50, Fallon to Ely, NV



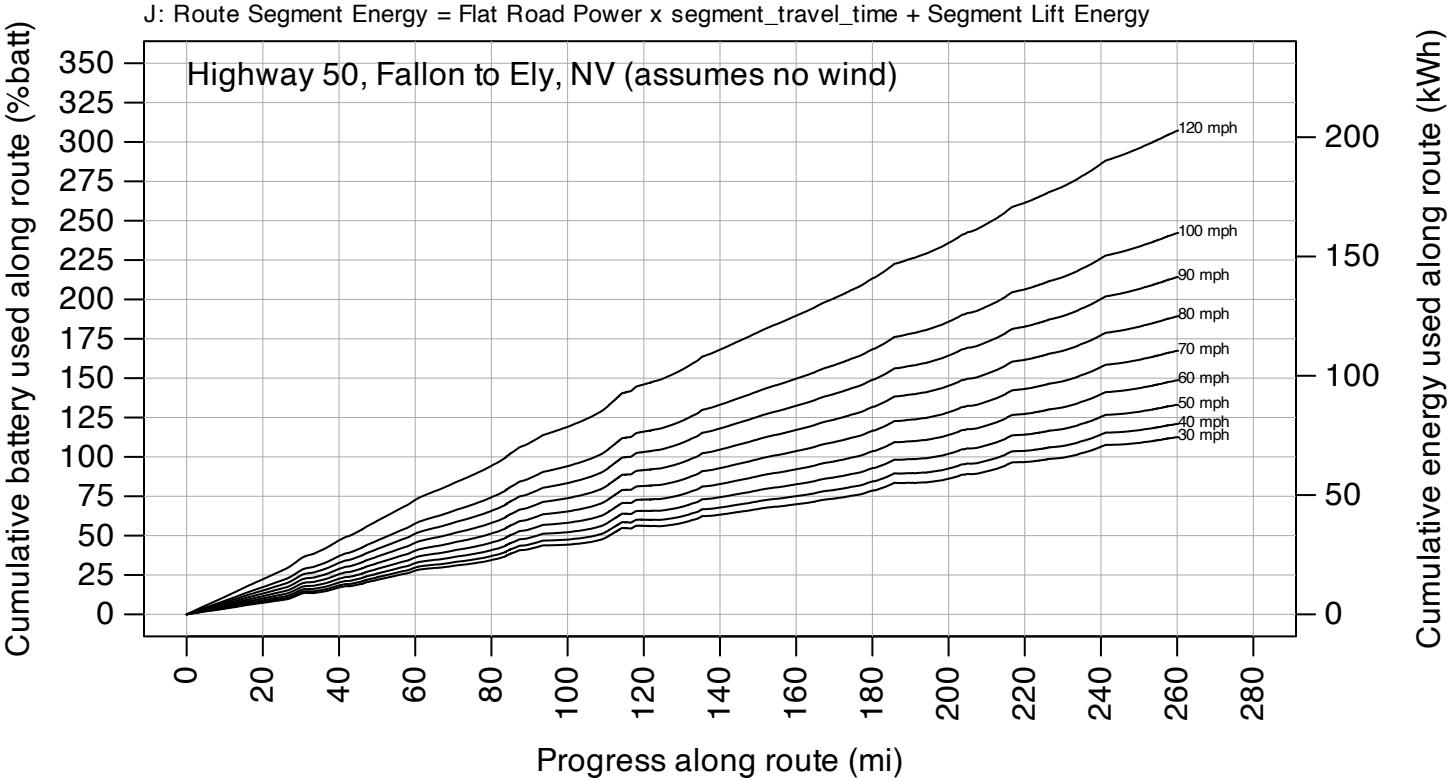
Energy used to travel route at various car and wind speeds

Assumptions: A: 2018 Tesla Model 3 LR RWD B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: weight 4250lb (with 250lb passengers) D: drag coef 0.22, roll coef 0.008 base power 0.61kW
E: frontal area 2.22sq. m. F: batt degraded 12% for 66kWh capacity
G: 70% net energy efficiency upon increased load, 70% regen energy recapture efficiency
H: Est. Total Power P = baseline+rolling+drag power (flat road)
I: Lift Energy = vehicleWeight_kg x N_per_kg x elev_change_m x energyEfficiencyFactor
J: Route Energy = Flat Road Power x travel_time + Lift Energy



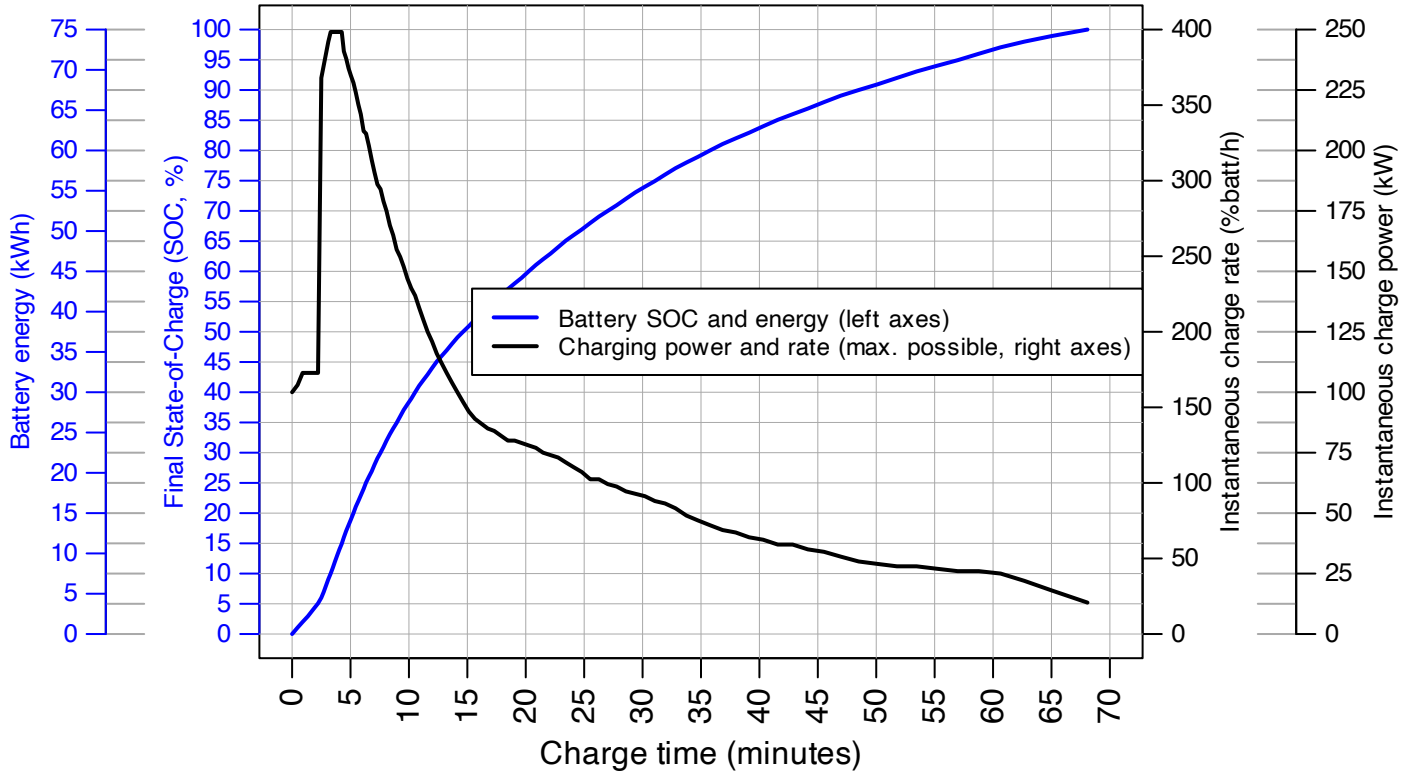
Energy usage along travel route at various car speeds

Assumptions: A: 2018 Tesla Model 3 LR RWD B: Testing: flat road, 85°F, elev 0 ft, 29.92 inHg, wind 0 mph
C: weight 4250lb (with 250lb passengers) D: drag coef 0.22, roll coef 0.008 base power 0.61kW
E: frontal area 2.22sq. m. F: batt degraded 12% for 66kWh capacity
G: 70% net energy efficiency upon increased load, 70% regen energy recapture efficiency
H: Est. Total Power P = baseline+rolling+drag power (flat road)
I: Segment Lift Energy = vehicleWeight_kg x N_per_kg x segment_elev_change_m x energyEfficiencyFactor
J: Route Segment Energy = Flat Road Power x segment_travel_time + Segment Lift Energy



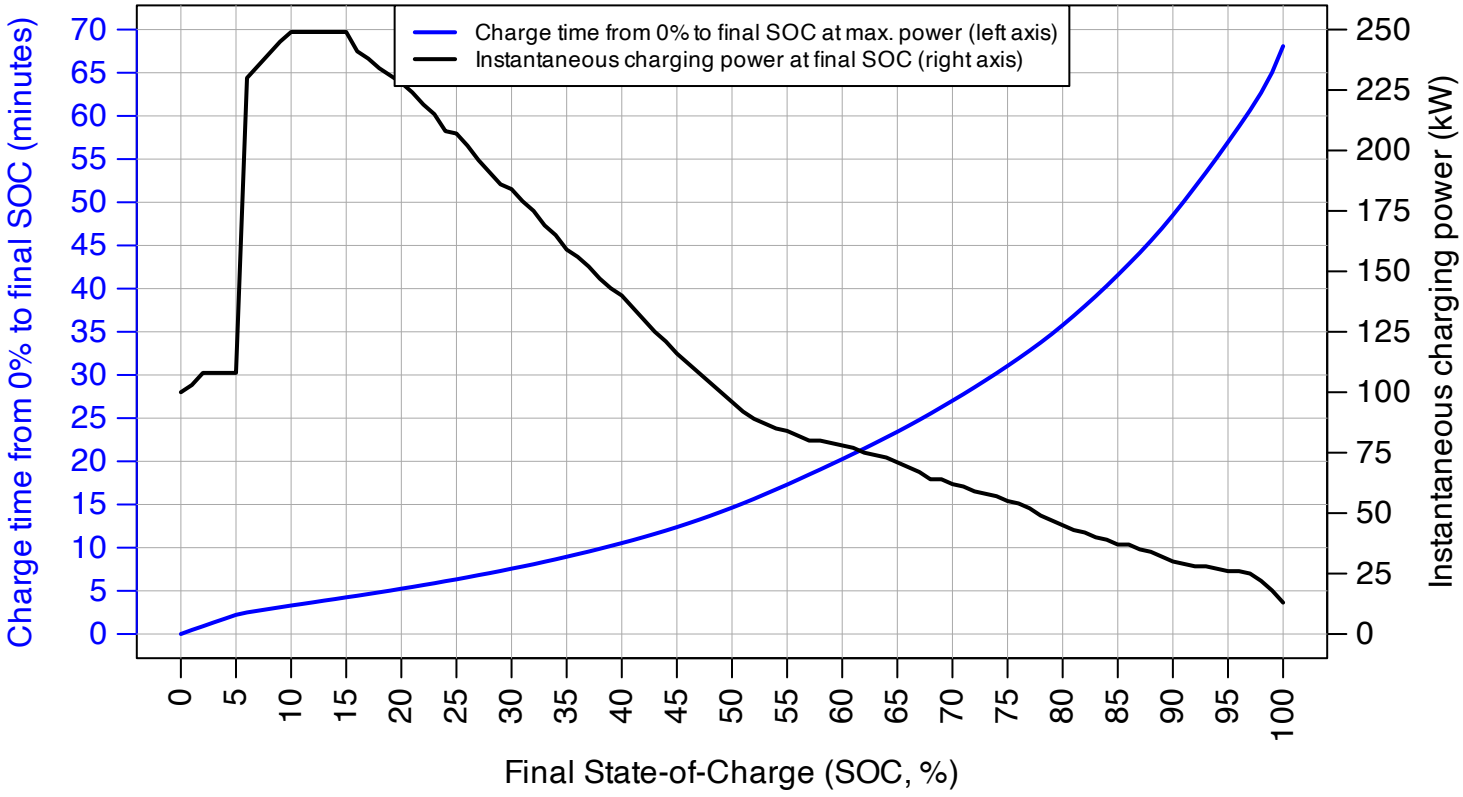
Instantaneous power, final SOC from 0% after charging X minutes at max charge power

Data is for maximum charge rate curve for Tesla Model 3 with 75 kWh battery, no degradation
(from https://evkx.net/models/tesla/model_3/model_3_long_range/chargingcurve)
(Assume charging is done at the maximum possible rate equal to the charging power shown on the right axis)



Instantaneous power, charge time from 0% to final SOC at max charge power

Data is for maximum charge rate curve for Tesla Model 3 with 75 kWh battery, no degradation
(from https://evkx.net/models/tesla/model_3/model_3_long_range/chargingcurve)
(Assume charging is done at the maximum possible rate equal to the charging power shown on the right axis)



Charge time from 0% to final SOC at various maximum charge powers

Data is for maximum charge rate curve for Tesla Model 3 with 75 kWh battery, no degradation
(from https://evkx.net/models/tesla/model_3/model_3_long_range/chargingcurve)