Alaska EV Technical Working Group – 3/22/2024

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Cold Weather EV Data Collection & Results

Data Samples

Lucid
- 2023 Air Pure AWD (88 kWh)

Teslas
- 2016 Model X 75D (75 kWh)
- 2020 Model Y LR (75 kWh)
- 2022 Model Y LR (75 kWh)

VW
- 2023 ID.4 AWD Pro S (77 kWh)

Data Collection

TezLab

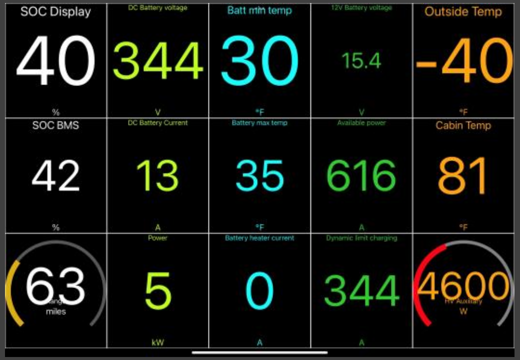
- Captures the data sent from the EV to “mothership” via API
- Con: Only for Teslas (Soon to be Rivians)
- Con: Data collected is based on Vehicle Estimates and not real world.

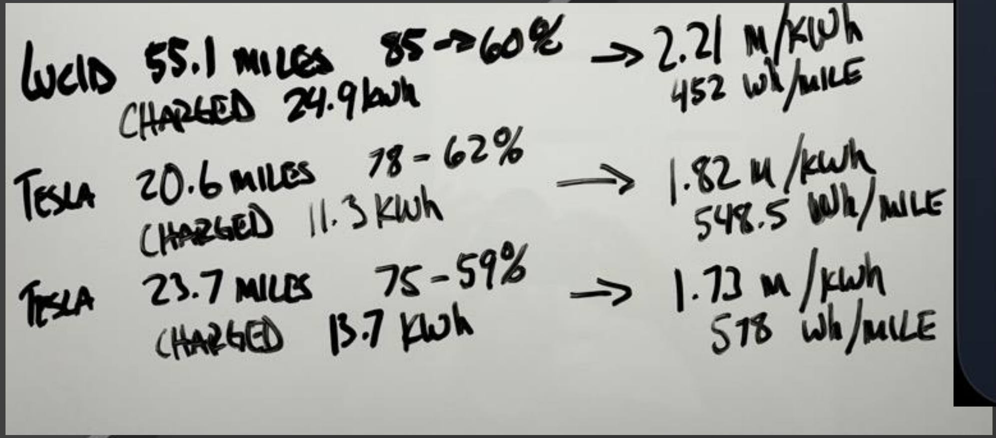
Whiteboard

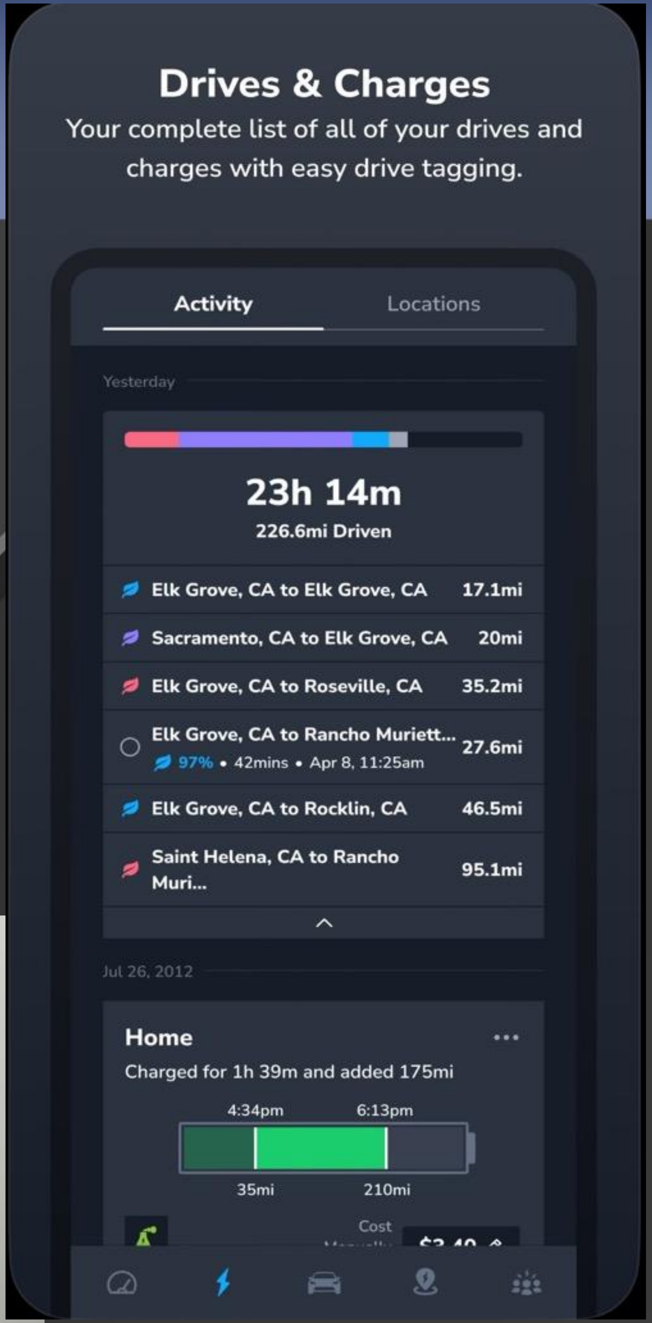
- Capturing the data provided by the EV and adding the measured energy delivered to the EV through a Tesla Gen3 Universal HPWC
- Con: Doesn’t capture every drive nor the bulk of sensor data from the vehicle

Car Scanner Pro

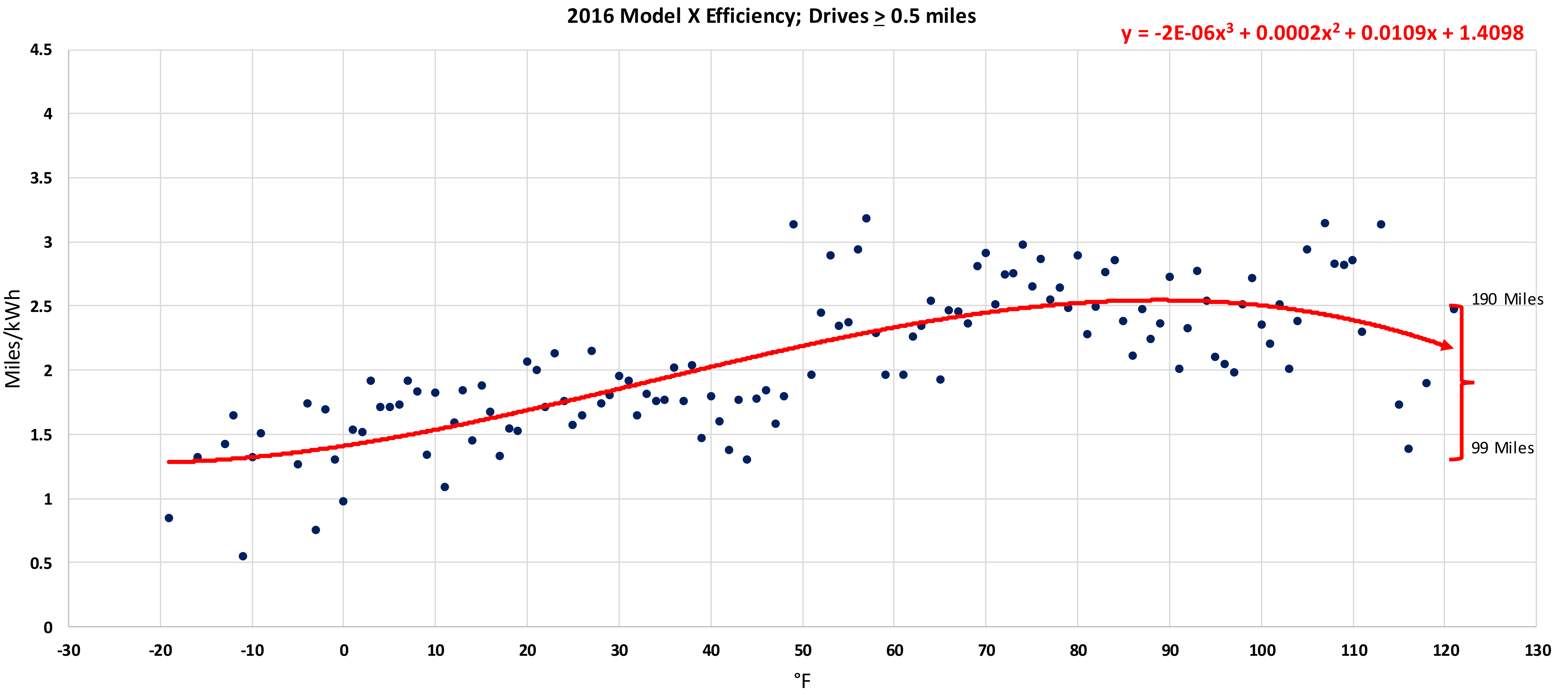
- Data logging via OBD port







Data Analytics Temp vs. Efficiency



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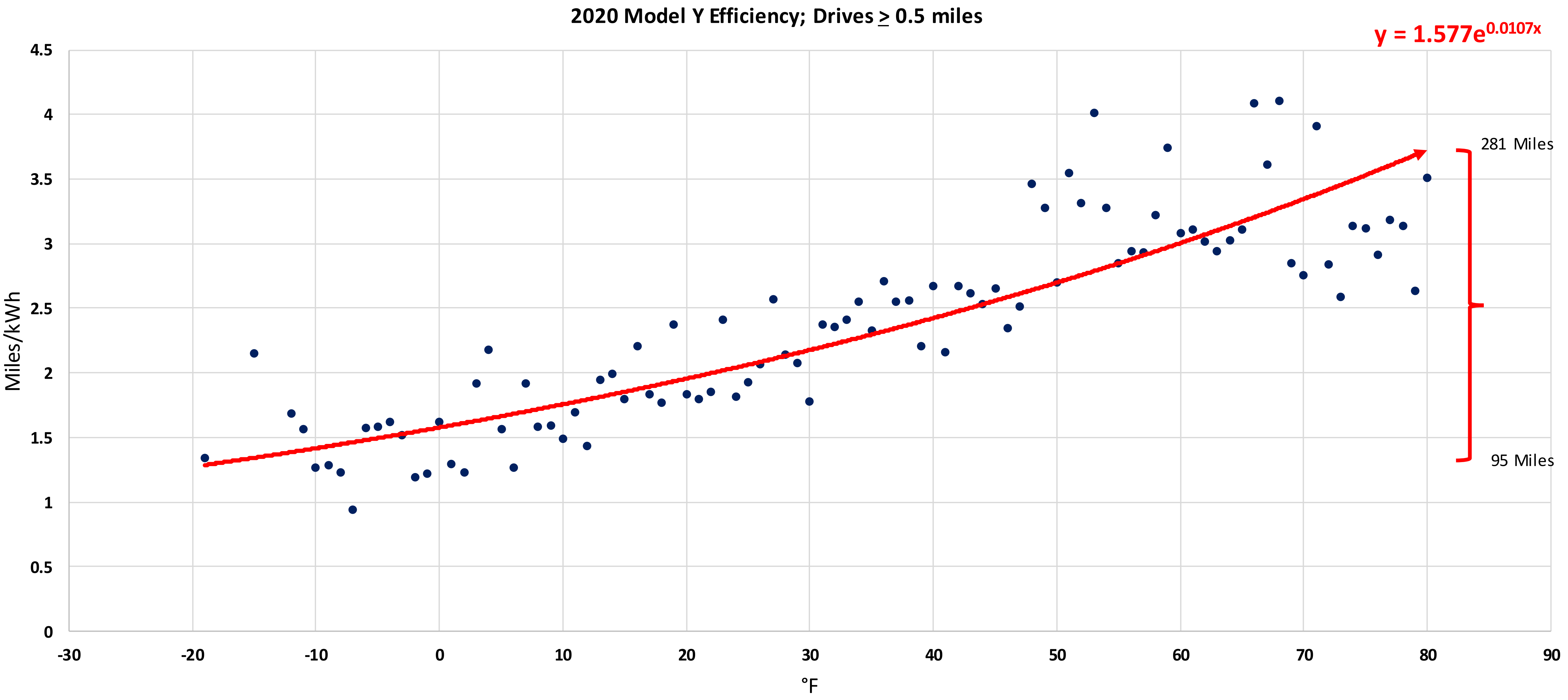

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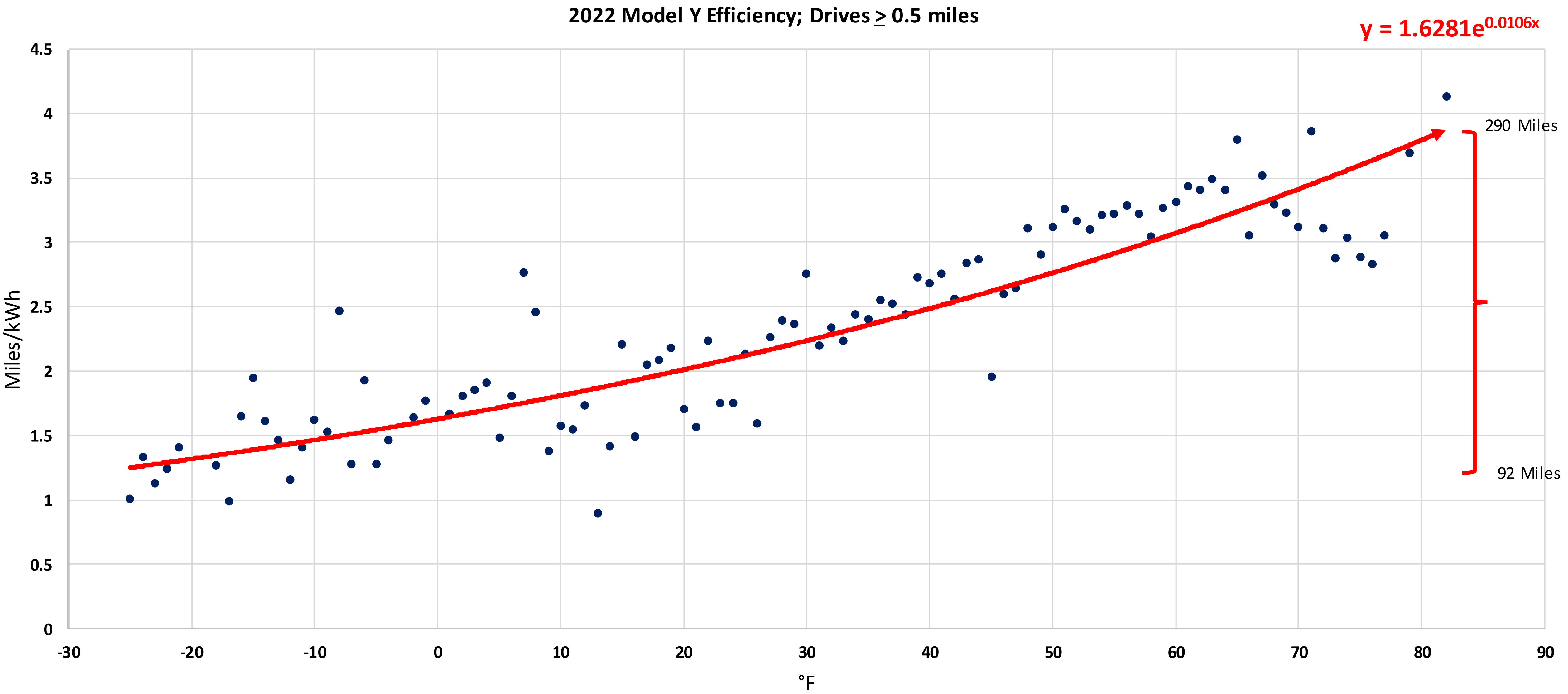

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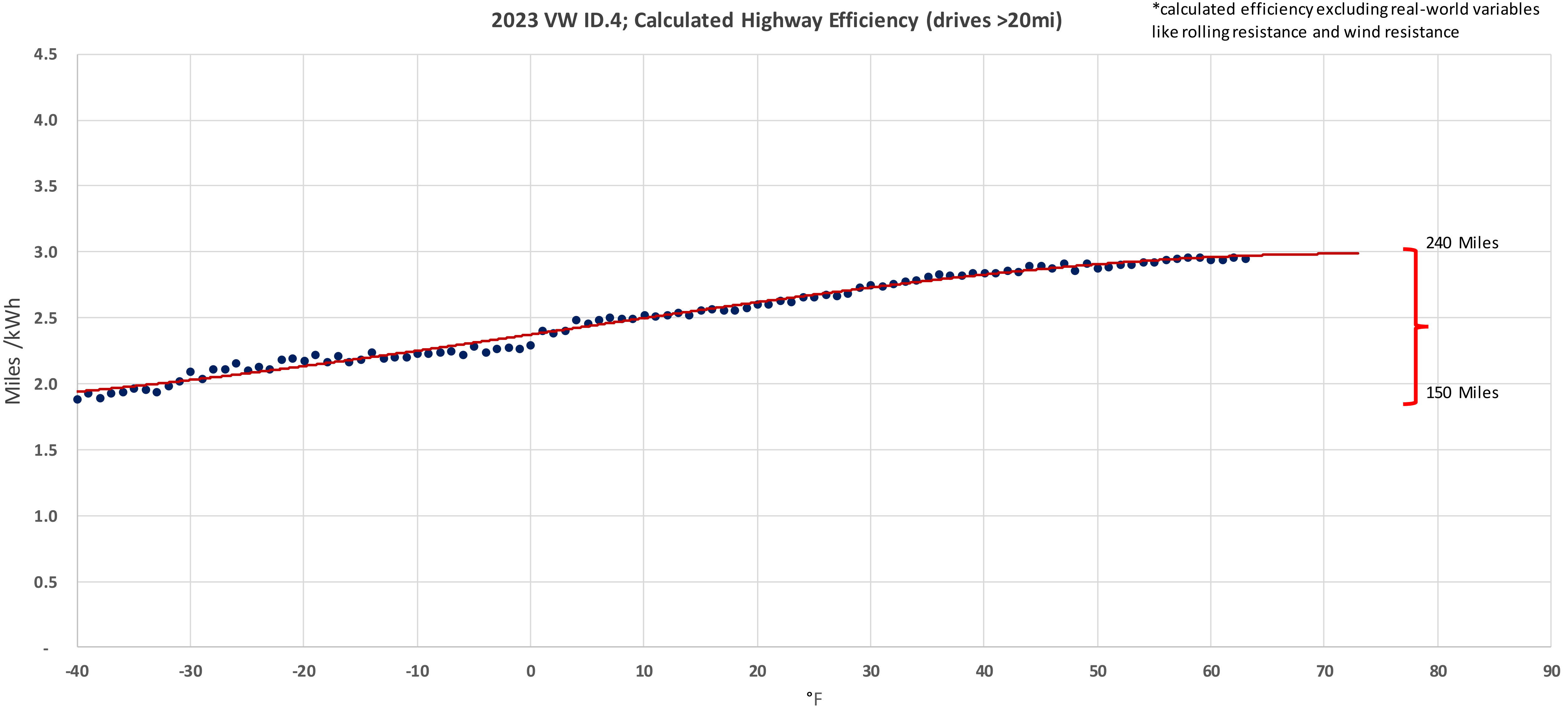
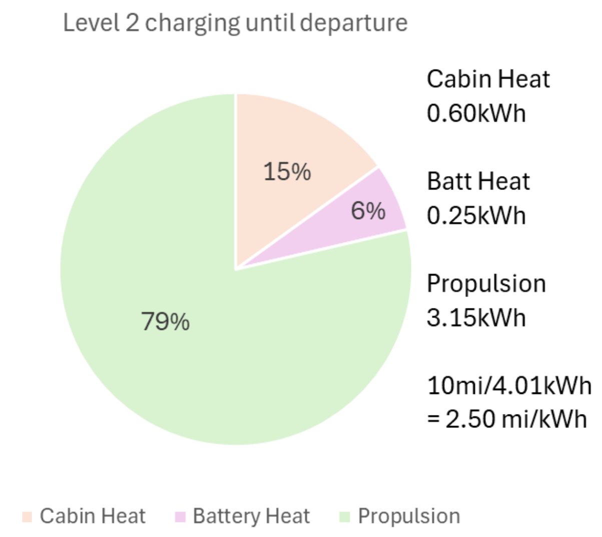


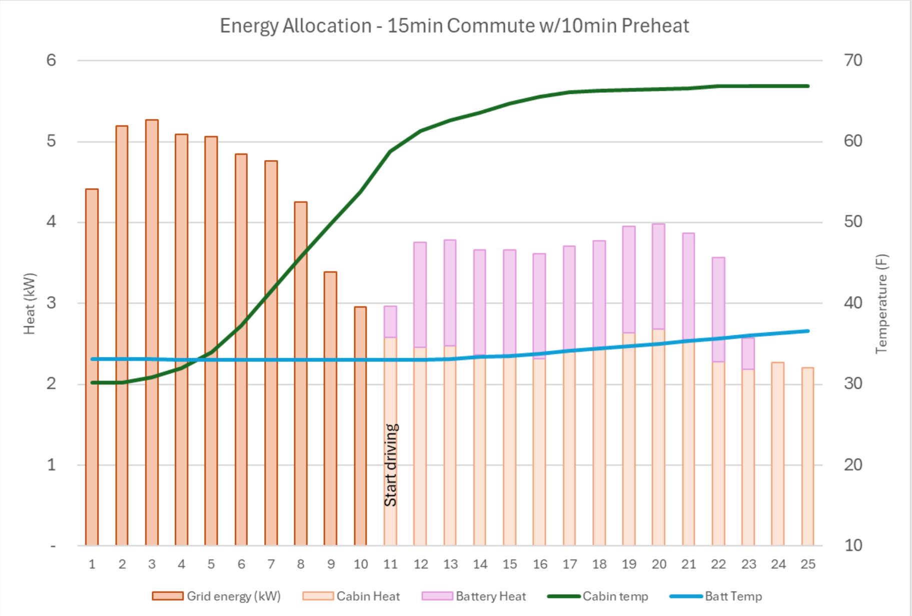
Cold Effects on Battery for Short Drives

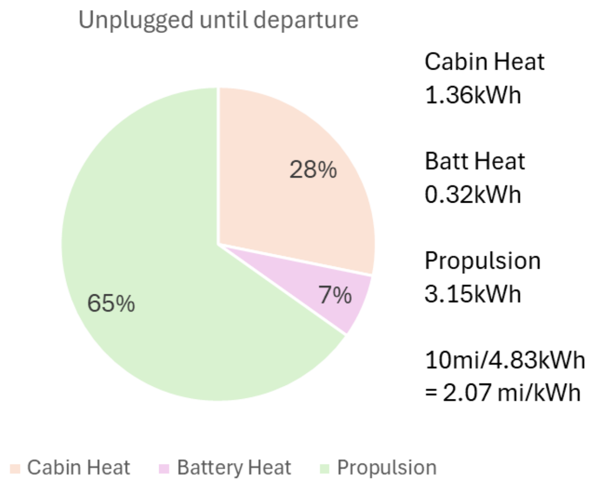
- Batteries store energy as a chemical reaction. Colder temperatures reduce the reaction.
- Allowing a battery to cold soak reduces its energy potential (see energy graph from Tesla)
- More energy is needed for cabin heating
- More energy is needed for battery heating
- High tire rolling resistance with softer rubber winter tires and snow on the roads
- Tesla ”Sweet Spot” is 60°F to 80°F. Above or below and more energy is used for maintaining battery temperature.

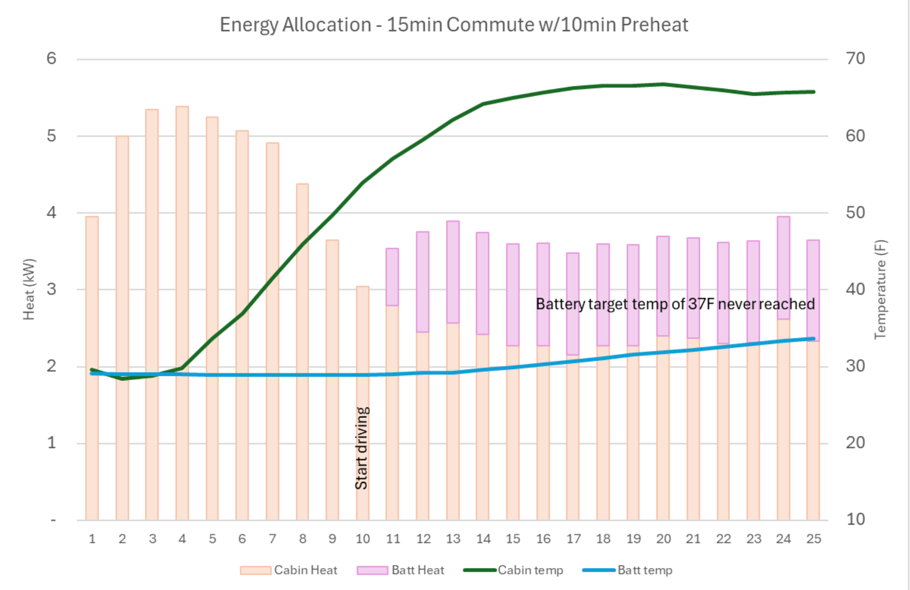
Cold Effects on Battery for Short Drives

- Parking in a garage has a big efficiency benefit
- Minimum battery temperature varies by EV model and manufacturer.
- Battery temperature if parked unplugged will be lower than when charging (L1 or L2).
- Preheating cabin can use energy from the battery or from the grid if charging.
- Charging between repeated short trips can help maintain battery and cabin temperature and improve indicated efficiency, although energy is still being used.
- L1 charging is useful for maintaining battery temperature (0.5-1.5kW) but can't support full cabin heating load (2-5kW+).
- Cabin warms and cools quickly especially in EV with glass roof.





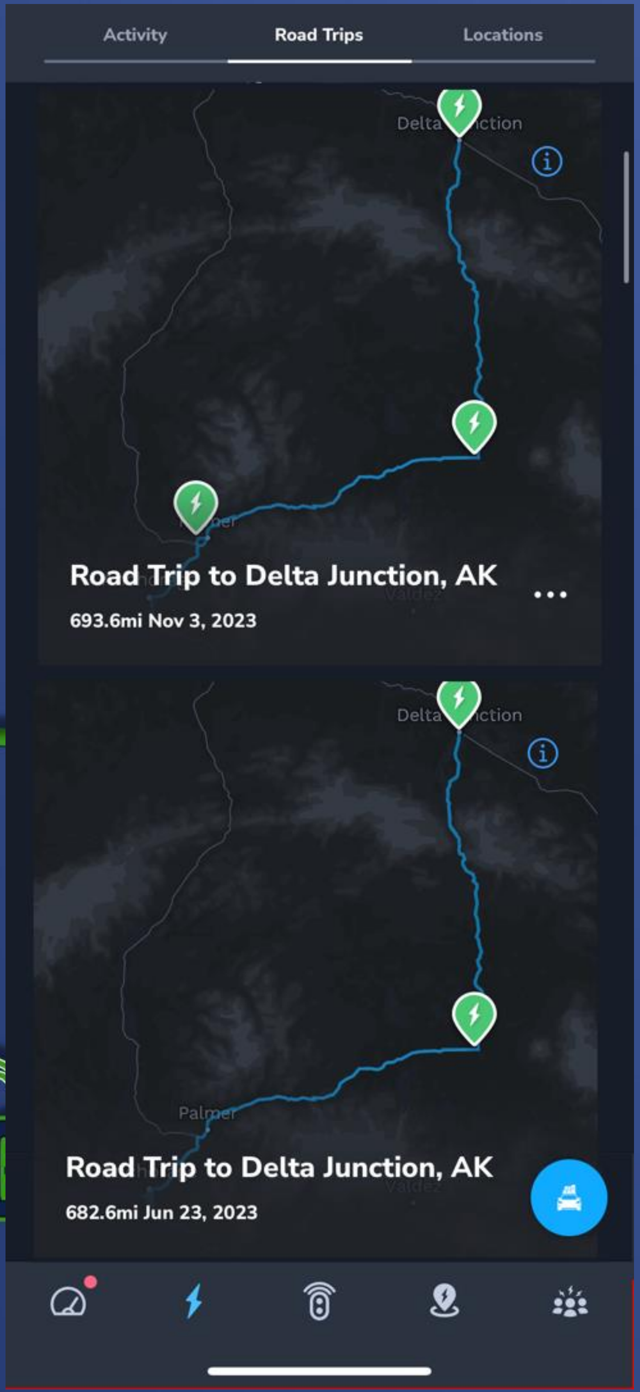




Cold Effects on Battery for Road Trips

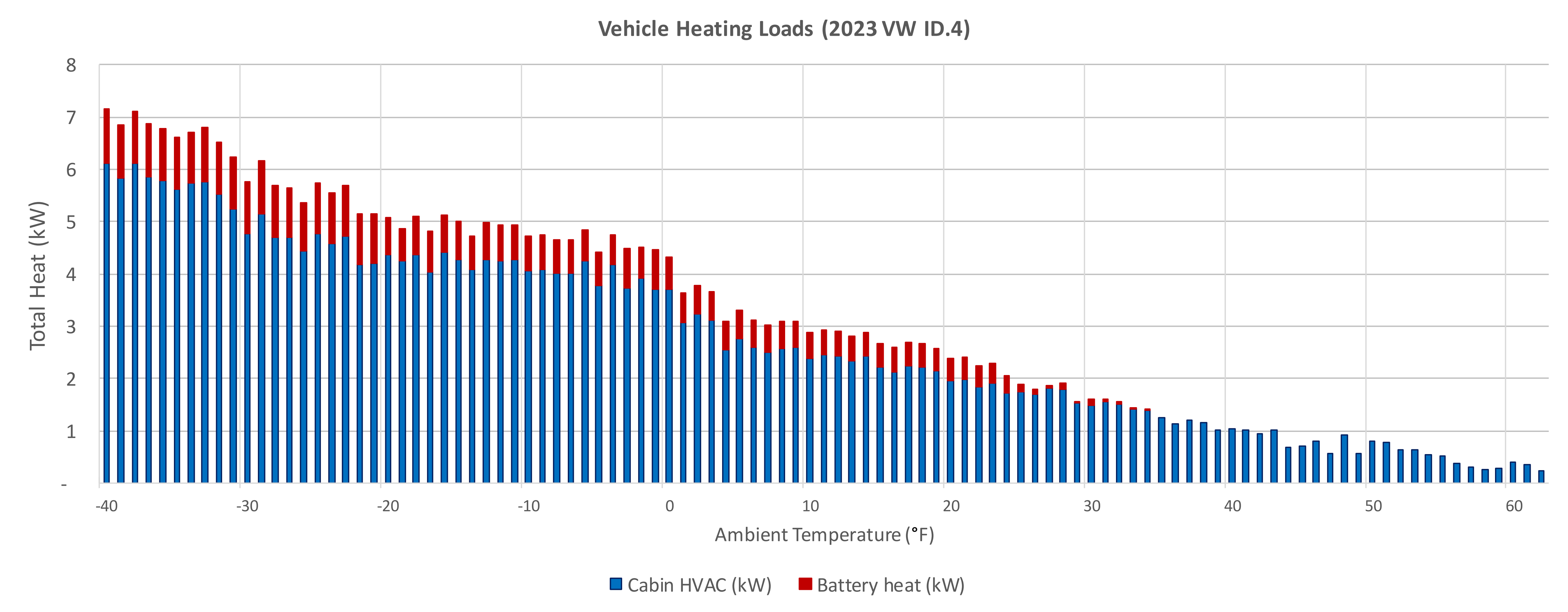
- Comparing same road trip in Summer versus Winter (warmer than typical Winter)
- Cold Soaking is not taking place.
- Summer miles is 691.9, Summer energy is 199.6 kWh, 3.47 miles/kWh, AVG Temp 63°F
- Winter miles is 693.6, Winter energy is 238.8 kWh, 2.90 miles/kWh, AVG Temp 26°F
  - Added a charging stop in Palmer as required an additional 10% more battery to make the drive to Glennallen.
- Additional 39.2 kWh required for same road trip at 37°F colder than Summer

6/23/23	Miles	Battery % Used	Energy (kWh)	miles/kWh	AVG Temp (°F)
ANC to Glen	197.1	77%	60.70	3.25	54
Glen to Delta	152.9	52%	41.30	3.70	63
Delta to Glen	152.7	60%	44.20	3.45	68
Glen to ANC	189.2	68%	53.40	3.54	68
11/3/23					
ANC to Glen	194.2	87%	66.00	2.94	28
Glen to Delta	154.3	72%	54.30	2.84	22
Delta to Glen	154.3	74%	55.70	2.77	25
Glen to ANC	190.8	83%	62.80	3.04	29



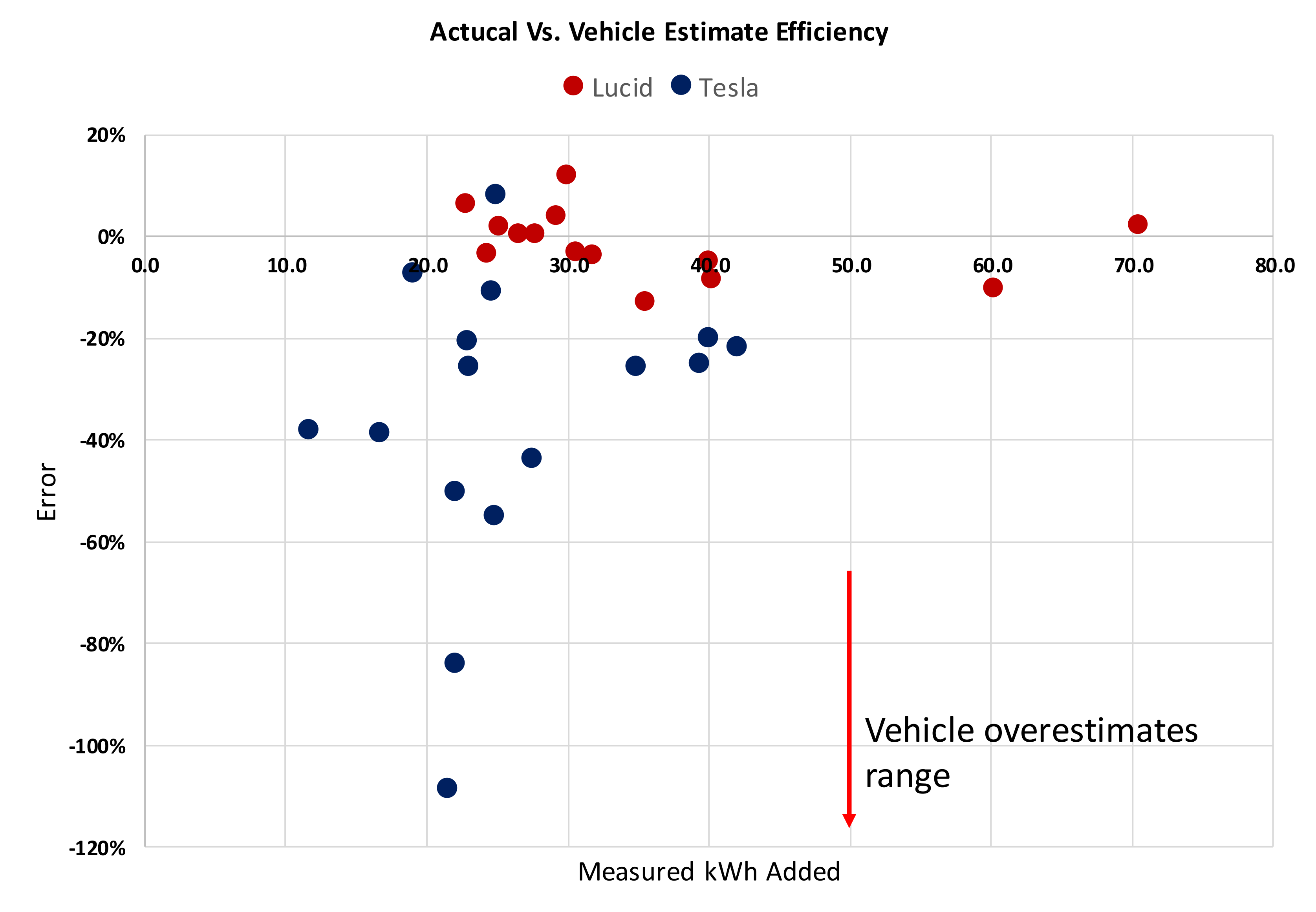
Cold Effects on Efficiency for Road Trips

- Heating loads are determined by the difference between the cabin/battery temp and ambient temp
- If stopping at DC fast chargers the battery is heated at each stop and declines gradually over 2-3 hours
- More frequent stops will require less battery preconditioning and may result in higher initial charging speeds
- Beginning a long trip with a cold battery may result in using more energy for battery heat



Data Analytics Actual vs. Estimated

- Some vehicles do not report the energy that is lost to cold soaking or phantom draining.
- This graph represents the error between what the vehicle reported used and the amount of energy added to the vehicle.

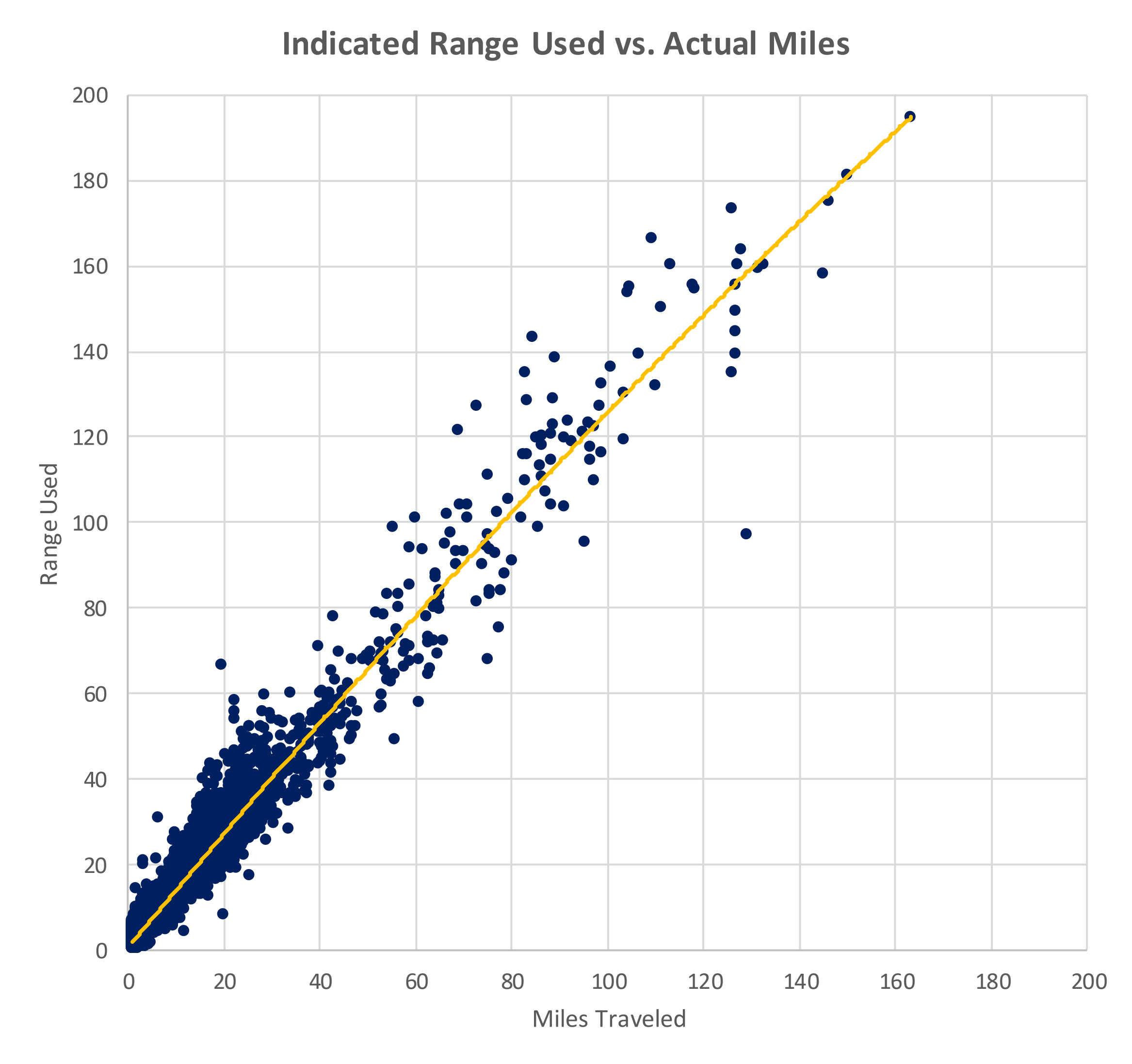


Data Analytics Actual vs. Estimated

- Example figure shows 4,500 trips >1.5miles from 2016 Model X and 2020 Model Y.

- Some EVs are optimists and some pessimists
- Frequent short trips will cause estimated range to be significantly lower than actual range
- Knowing your usable battery capacity allows easy range estimates on the fly as conditions change
- Example: 100% SOC = 77kWh @ 2.8 mi/kWh = 216 miles

  65% SOC = 50 kWh @ 2.2mi/kWh = 110 miles



Conclusion

1. Frequent charging improves winter range by reducing energy from battery used for heating (**ABC** - **A**lways **B**e **C**harging). Frequent stops at DC fast chargers, when road tripping, can improve winter EV efficiency and increase charging speeds, reducing overall charging time.
   - Excess energy is expensed for Preconditioning the battery

2. More efficient EVs will be more impacted by winter conditions (temperature, rolling resistance of winter tires, snow, etc.)
   - Lucid is rated at 4.4 miles/kWh but during the winter months, achieved an average of 2.3 miles/kWh
   - Cold Soaking batteries greatly reduces range

3. Level 2 chargers in urban environments can improve winter EV efficiency, increase range, and make EVs more convenient.

4. High-amperage Level 2 chargers (40-80A) are especially useful during winter months by allowing simultaneous heating and charging for most EVs.