VED ML Data Modelling

ICE, HEV, EV, and PHEV Analysis | Supervised Learning | Unsupervised Learning

ICE, HEV, EV, and PHEV Analysis: Distance vs FCR and HV Battery Power

The tables below show a comparison of key metrics for different vehicle types:

- **ICE & HEV**: Internal Combustion Engine and Hybrid Electric Vehicles
- **EV & PHEV**: Electric Vehicles and Plug-in Hybrid Electric Vehicles

The data is grouped by trip, time and vehicle type, and displays the top records for each group.

ICE & HEV Vehicles

	Trip	Vehicle Type	Latitude[deg]	Longitude[deg]	Air Conditioning Power[Watts]	Heater Power[Wa
3086	1637	ICE	42.2757	-83.6822	None	N
339	293	ICE	42.268	-83.6803	None	N
422	340	ICE	42.2699	-83.696	None	N
1196	719	HEV	42.2473	-83.6981	None	N
2801	1455	ICE	42.2451	-83.7194	None	N
3480	2016	ICE	42.2582	-83.7506	None	N
3704	2678	ICE	42.2543	-83.7398	None	N
1817	986	ICE	42.272	-83.7017	None	N
3713	2705	ICE	42.2785	-83.74	None	N
731	507	ICE	42.2714	-83.7275	None	N

EV & PHEV Vehicles

	Trip	Vehicle Type	Latitude[deg]	Longitude[deg]	Air Conditioning Power[Watts]	Heater Power[Wa
2967	1565	PHEV	42.2944	-83.7926	None	N
375	315	PHEV	42.2681	-83.7193	0	N
810	548	PHEV	42.287	-83.7257	None	N
815	550	PHEV	42.2871	-83.7255	None	N
1011	644	PHEV	42.3168	-83.6995	None	N
717	499	PHEV	42.285	-83.735	None	N
310	276	PHEV	42.2969	-83.6933	None	N
680	485	PHEV	42.26	-83.7294	None	N
423	340	PHEV	42.2953	-83.7221	None	N
1009	643	PHEV	42.2719	-83.7056	0	N

Comments:

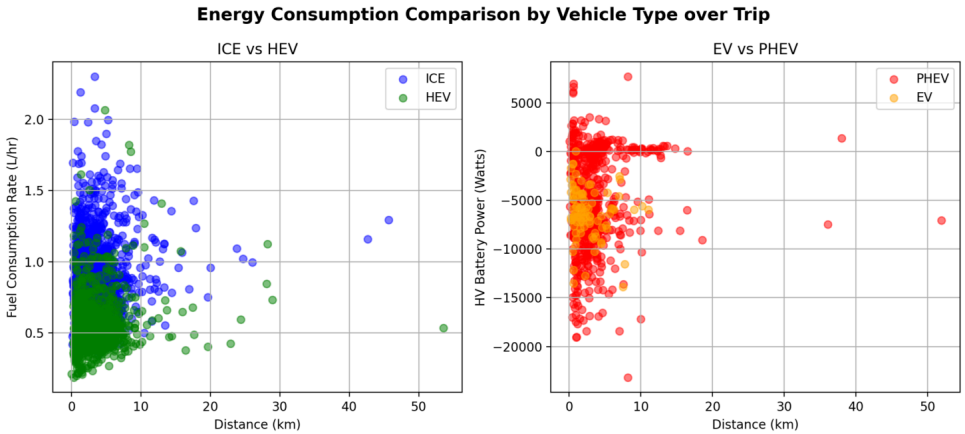
- The tables above provide a summary of distance, fuel consumption rate (FCR), and HV battery power for ICE, HEV, EV, and PHEV vehicle types.
- This allows for a direct comparison of energy consumption and operational characteristics across different powertrain technologies.

Energy Consumption Comparison by Vehicle Type over Trip

The following scatter plots visualize the relationship between trip distance and energy consumption metrics for different vehicle types:

- **Left Plot:** Distance vs Fuel Consumption Rate (FCR) for Internal Combustion Engine (ICE) and Hybrid Electric Vehicles (HEV).
- **Right Plot:** Distance vs HV Battery Power for Electric Vehicles (EV) and Plug-in Hybrid Electric Vehicles (PHEV).

These visualizations help compare operational efficiency and energy usage patterns across various powertrain technologies.



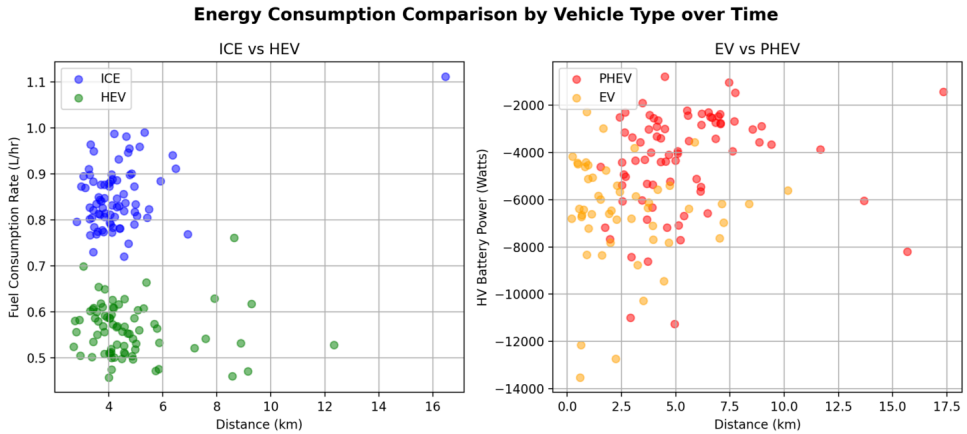
- **ICE vs HEV Plot (Left):** Shows a negative correlation between distance and fuel consumption rate, where fuel consumption tends to be higher (1.5-2.0 L/hr) at shorter distances (0-10 km) and decreases (below 1.0 L/hr) as trip distance increases. ICE vehicles (blue) generally show higher fuel consumption compared to HEV vehicles (green) across all distances
- **EV vs PHEV Plot (Right):** Shows the battery power usage pattern, where PHEV vehicles (red) exhibit both positive and negative power values (-20000 to +5000 Watts) indicating both battery discharge and regenerative charging, while EV vehicles (yellow) appear to have a more concentrated power usage pattern. The spread of power values is most diverse in the 0-10 km range and becomes more sparse at longer distances.
- These plots enable a visual comparison of energy consumption patterns across different vehicle technologies.

Energy Consumption Comparison by Vehicle Type over Time

The following scatter plots visualize the relationship between trip distance and energy consumption metrics for different vehicle types over time:

- **Left Plot:** Distance vs Fuel Consumption Rate (FCR) for Internal Combustion Engine (ICE) and Hybrid Electric Vehicles (HEV).
- **Right Plot:** Distance vs HV Battery Power for Electric Vehicles (EV) and Plug-in Hybrid Electric Vehicles (PHEV).

These visualizations help compare operational efficiency and energy usage patterns across various powertrain technologies over time periods.



- **ICE vs HEV Plot (Left):** Shows that ICE vehicles (blue) have higher fuel consumption rates (0.8-0.9 L/hr) compared to HEV vehicles (green) (0.5-0.6 L/hr) over time. The data points are concentrated around 4 km distance, with a few outliers extending up to 16 km, showing HEV's consistently better fuel efficiency across different time periods.
- **EV vs PHEV Plot (Right):** Displays battery power consumption between -2000 to -14000 Watts for both vehicle types, with PHEV (red) showing slightly more scattered power usage compared to EV (yellow). The majority of data points fall within 0-7.5 km range, with occasional trips extending to 17.5 km, suggesting these represent typical daily driving patterns over time.
- These plots enable a visual comparison of energy consumption patterns across different vehicle technologies and their temporal variations.

Individual Vehicle Type analysis by Trip: ICE, HEV, EV, PHEV

Data Overview: ICE Vehicles

	Trip	Latitude[deg]	Longitude[deg]	Air Conditioning Power[Watts]	Heater Power[Watts]	Vehic
count	1850	1850	1850	1850	0	
mean	1104.8449	42.2709	-83.73	0	None	
std	630.4095	0.0144	0.0242	0	None	
min	5	42.2282	-83.7991	0	None	
25%	597.25	42.2617	-83.7434	0	None	
50%	1066.5	42.2712	-83.7293	0	None	
75%	1560.75	42.2805	-83.7145	0	None	
max	2898	42.3177	-83.6763	0	None	

Data Overview: HEV Vehicles

	Trip	Latitude[deg]	Longitude[deg]	Air Conditioning Power[Watts]	Heater Power[Watts]	Vehicl
count	1164	1164	1164	1164	1164	
mean	983.2122	42.2716	-83.7329	0	0	
std	515.7728	0.0179	0.028	0	0	
min	8	42.2288	-83.7998	0	0	
25%	603.75	42.2603	-83.7511	0	0	
50%	939.5	42.2739	-83.7306	0	0	
75%	1289.5	42.2835	-83.7112	0	0	
max	2932	42.3168	-83.6794	0	0	

Data Overview: EV Vehicles

	Trip	Latitude[deg]	Longitude[deg]	Air Conditioning Power[Watts]	Heater Power[Watts]	Vehic
count	95	95	95	95	95	
mean	1274.1053	42.2713	-83.7355	451.2064	595.9481	
std	533.4194	0.0179	0.0235	389.5322	766.1758	
min	554	42.2314	-83.7924	0	0	
25%	737	42.2608	-83.7496	79.9732	0	
50%	1149	42.2725	-83.7362	370.6107	307.5658	
75%	1806	42.2847	-83.724	785.391	852.6016	
max	2165	42.3075	-83.6822	1224.1532	3545.2824	

Data Overview: PHEV Vehicles

	Trip	Latitude[deg]	Longitude[deg]	Air Conditioning Power[Watts]	Heater Power[Watts]	Vehic
count	618	618	618	618	618	
mean	1027.3932	42.2739	-83.7236	27.3153	0	
std	579.9187	0.0191	0.0251	165.7691	0	
min	2	42.2298	-83.7996	0	0	
25%	590	42.2598	-83.7396	0	0	
50%	955.5	42.2777	-83.7191	0	0	
75%	1457.75	42.2861	-83.7073	0	0	
max	2432	42.319	-83.6781	2008.7214	0	