Energy Products Data Analysis Test

Your submission time will be considered alongside the strength of your solution. Please time yourself when you begin the test and let us know how long it took you to finish.

Context:

A battery has limited energy and power capacity for charging and discharging. In this exercise we restrict our discussion to battery charging but similar concepts apply to discharging too.

When a battery is close to getting full, its charge power capacity decreases from its rated capacity to 0 since it no longer can accept more energy into it.

However, there could be other events like battery faults or temperature increases which can result in battery decreasing its charge power capacity below its rated capacity. This problem is aimed at using sample fleet data to understand percentage of time batteries derate their power capacity for reasons other than when its close to getting full.

Signal Names and Terminology:

Table below defines battery related signals used in this problem set.

Signal	Description
PW_EnergyRemaining	Energy left in the battery in Watt-hour units.
PW_FullPackEnergyAvailable	Total energy capacity the battery has in Watt-hour units. This can vary by small amounts over time
PW_AvailableChargePower	Maximum power capacity in Watts (W) at which battery can charge.

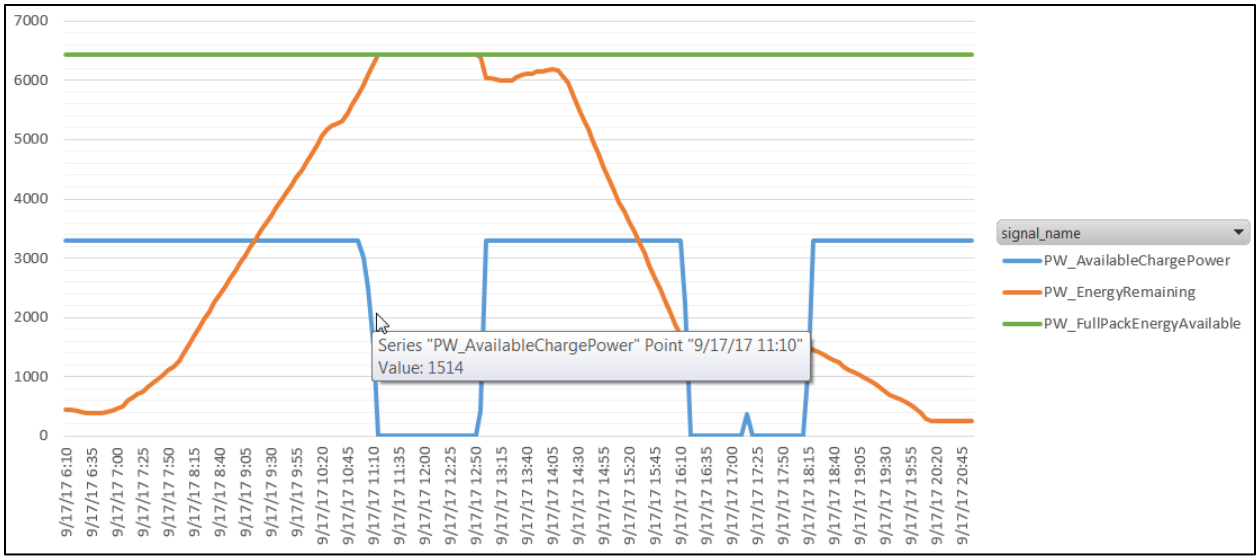
A few other terms:

- State of energy of battery is defined as ratio of PW_EnergyRemaining to PW_FullPackEnergyAvailable. Physically, it signifies the % amount of energy left in the battery. **For the purpose of this exercise we consider a battery "starting" to get full if SOE > 90%**

- The rated charge power capacity of battery in this problem is **3300 W**. In other words, PW_AvailableChargePower nominally is expected to be 3300 W except when it derates.

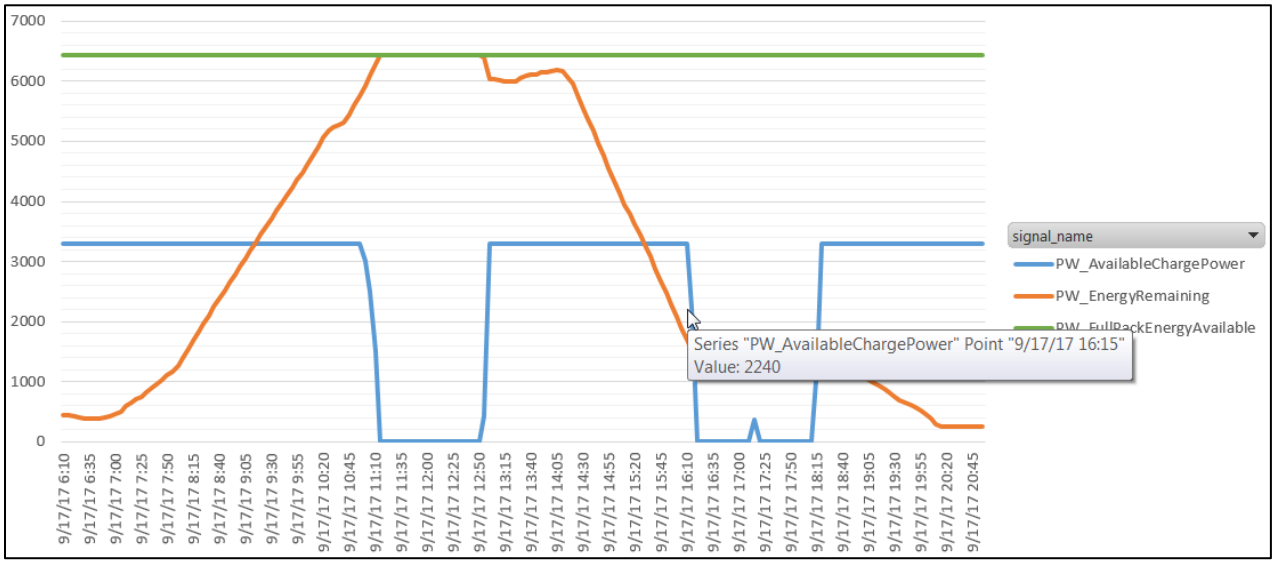
Example 1 – Charge power derating as battery is getting full

In below case, PW_AvailableChargePower derates from rated value of 3300W to 1514W when SOE is 6289/6443 = 97.6%. In this case, PW_AvailableChargePower decreases as battery is close to getting full



Example 2 – Charge power derating due to other reasons

In below case, PW_AvailableChargePower derates from rated value of 3300W to 2240W at 16:15 hours when PW_EnergyRemaining is at 1521 Whr and PW_FullPackEnergyAvailable is at 6443W i.e. SOE = 23.6%. In this case battery is far from getting full.



Exercise:

Please write a program that would read battery time series data provided in 5 attached csv files (one file per battery) and calculate:

1. Monthly average of percentage time for which Battery 001 (data set under "001.csv") has its PW_AvailableChargePower greater than or equal to its rated capacity of 3300 W. We call this metric "charge power availability". It signifies % time for which battery can charge at its rated

capacity if commanded to do so. Please use a visualization of your choice to represent the output of this data. The audience for the visualization would be both a technical and non-technical audience.

2. Monthly charge power availability for Battery 001 but excluding data points where charge power is below its rated value due to battery close to getting full (i.e. SOE > 90%). Also, please provide a visualization to show the new monthly charge power availability.

3. Extend questions 2 above to calculate monthly charge power availability for all 5 batteries combined and again excluding data points where charge power is below its rated value due to battery close to getting full. Please provide a visualization to show this combined monthly charge power availability.

We would strongly prefer the program to use Python but you can choose to write it in a language of your choice. Please send us back your output visualizations and your source code including readme instructions on how to run that code.

A few things to keep in mind on data set provided:

- Timestamps in these data files is in Unix epoch time in **milliseconds** https://en.wikipedia.org/wiki/Unix_time
- Each of the 3 signals report every 5 mins though they may not report at the same time. Your program will have to account for this