May 15th, 2023

Ms. Cory-Ann Wind
Oregon Clean Fuels Program Manager
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(503) 869-1326

RE: Proposed Alternative Estimation Methodology for Forklift Truck Electricity Usage

Dear Ms. Cory-Ann Wind and DEQ CFP Team,

Thank you very much for the response to our inquiries on changes to the DEQ Fuel Supply Equipment registration and reporting. In this letter, we propose an estimation methodology that addresses the concerns that DEQ has voiced most recently in the April 28th response email with subject title "Changes to Fuel Supply Equipment Registration" updates". As requested in the email, these are our thoughts for your discussion on what the approved alternative methodology should be.

Proposed Estimation Method

Given the above and the time it will take to deploy meters, we would like to propose an estimation method that addresses the concerns that the DEQ has voiced.

As you may know, in California, CARB has approved an estimation methodology to calculate the recharge kWhrs to operate a forklift truck. We do acknowledge that the CARB alternative methodology may not reflect actual forklift operations. In fact, CARB is in the process of updating its rulemaking to require metering, which is slated to start in 2024.

To give some background to how industrial batteries are sized and used in industrial forklift truck applications, most battery manufacturers specify that 80% of the battery capacity can be used over a single 8-hour shift. As such, the charger must return the 80% capacity depleted before the battery can be used for another shift. In reality, the energy returned will be greater than 80% to account for overcharge and battery / charger losses.

Given SCT's extensive battery and charging expertise, SCT has a wealth of charging data that it used to extract the recharge kWhr for industrial batteries. As part of SCT's prior work with Advanced Charging Technologies to develop and certify industrial chargers through the California Energy Commission (CEC) and receive CEC certification, SCT has tested a large number of industrial batteries and chargers and collected extensive charge return data (recharge kWhrs and efficiencies), which were submitted for CEC certification. Based on well documented historical data, SCT developed the following estimation method to calculate the recharge kWhrs per 8-hour shift for a given size battery, namely:

$$Recharge\ kWhr\ per\ 8-hour\ shift = \frac{Charging\ VPC\ \times\ \#\ of\ Cells\ \times \%\ DOD\ \times CRF\ \times Battery\ AHr\ Capacity}{Charger\ Efficieny}$$

Where:

- Charging VPC: Average battery charging voltage per cell
- # of Cells: # of 2V cells for an industrial battery
- CRF: Charge return factor, which accounts for the overcharge required to fully charge the battery (typical value is 110%)
- Battery AHr Capacity: Battery Nameplate Ahr rating
- %DOD: % Depth of Discharge (default 80% for an 8-hour shift)
- Charger Efficiency: Charger efficiency (typical value is 90%)

The above formula can be easily applied as all the parameters are derived from the battery nameplate data (all what is needed is the battery voltage and Ahrs). As for the charging voltage per cell and using our extensive database of measured charge return data, we found that a ~2.33 V[1] represent a conservative estimate compared to actual measurements.

Accounting for Actual Truck Operation

Since the above formula assumes that the battery is operated for 8 hours every shift and to address the DEQ concern that estimation methodologies may not reflect actual forklift operation, we propose adjusting the above formula to account for actual forklift truck operation. To account for actual truck operation, we propose using the forklift truck hour meter in the calculation methodology. *The forklift hour meter is a robust and reliable means of tracking forklift truck usage as it is used by leasing and rental companies to bill operators for forklift truck usage.*

To incorporate the forklift truck hour meter data, we need to estimate the *Recharge kWhrs per hour* by dividing the previous formula by 8 hours, namely:

$$Recharge\ kWhr\ per\ HOUR = \frac{Recharge\ kWhrs\ per\ 8-hour\ shift}{8\ Hrs}$$

We can then ask the facilities to send us signed quarterly reports of actual truck meter hours, which can then be used to calculate the recharge kWhrs for a given forklift truck, namely:

$$Recharge\ kWhr\ for\ a\ given\ Truck = Recharge\ kWhrs\ per\ Hour \times Actual\ Truck\ Meter\ Hours$$

We believe that the proposed methodology will allow the DEQ to have a more accurate estimation methodology that reflects current forklift operations until the time when meters can be installed and reported. If approved, the proposed alternative methodology can be used by all

[1] Based on extensive measured and recorded charging data for different battery sizes

registered parties to report forklift truck usage.

Caution. The earliest that we can start employing the above formula is Q4 2023 as we do not have access to truck hour meters for lapsed quarters, namely Q1 and Q2 2023 and it will take a while to notify all of our customers to start recording and reporting truck meter back to us. As such, we would kindly ask the DEQ to allow us to report Q1, Q2 and Q3 2023 data based on scheduled truck hours, which we have detailed audit trail and records of, and then transition to using the forklift truck meter hours staring Q4 2023.

We will be more than happy to schedule a call and share with the DEQ our data and how the proposed estimation methodology fits well with measured data/

Thank you for taking our comments into consideration. We look forward to continued participation and discussion.

Respectfully.

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