

Field Study of Industrial High Frequency Battery Chargers

Battery-powered lift trucks (Figure 1) are utilized throughout manufacturing facilities, airports, warehouses, and retail buildings for material handling. The number of battery-powered lift trucks used in Minnesota is estimated to be quite large: In the industrial sector alone, field experience indicates that the typical manufacturer has at least one battery-powered lift truck, and the state of Minnesota has approximately 7,300 businesses that are classified by NAICS code as manufacturing.¹



Figure 1. A typical powered lift truck (photo courtesy of Franklin Energy)

There are three types of battery chargers commonly used to power lift trucks: ferroresonant (FR), silicon-controlled rectifier (SCR), and high frequency (HF). Local suppliers estimate that the vast majority of industrial battery chargers used in Minnesota today are silicon-controlled rectifier (SCR) or ferroresonant (FR) chargers. These battery charging types have long been in existence and proven

to be very reliable for high power applications. However, high frequency (HF) chargers, the newest technology of the three, have gained a market foothold in recent years.

HF chargers are typically promoted as being more energy efficient than conventional chargers, and are usually sold at a higher cost. A landmark study by the Pacific Gas and Electric Company (PG&E) in 2009 involving standardized testing of a large number of industrial battery chargers demonstrated that HF chargers can offer significant energy efficiency improvements over FR or SCR chargers.² Some manufacturers also promote HF chargers as providing opportunity charging capability, in which batteries are charged at a very high rate during breaks in the workday. In contrast, under a conventional charging approach, batteries are run down to low levels, then slowly charged overnight and/or during off-peak hours. Opportunity charging can offer productivity and safety benefits for some businesses.

A recently completed CARD study conducted by [Franklin Energy](#) set out to evaluate the actual performance of HF chargers in the field. Field testing was completed at a total of nine facilities across

Minnesota and South Dakota, comprising a total of 13 charging stations. At each site, energy loggers were installed to monitor existing FR or SCR chargers for a period of two weeks of normal production activity. Next, HF chargers were installed, and energy loggers were installed to monitor the new HF chargers over an additional two weeks of normal production activity (Figure 2). The resulting pre- and post-energy logging data was then analyzed to determine energy savings. Franklin also analyzed the data to detect any impacts on peak demand from installing the HF chargers, which could occur if lift-truck operators switched to opportunity charging.



Figure 2. Battery charger station with existing and high frequency batteries being monitored (photo courtesy of Franklin Energy)

The field test results were puzzling. Installing HF chargers did not consistently reduce the energy consumed per charge cycle, or total energy use per day, which would have been expected from the PG&E results; in some sites, energy consumption actually increased with the HF chargers. There was also no consistent impact on peak demand, though operators generally did not take advantage of the ability to opportunity charge with the new HF chargers. However, the testing arrangements generally had significant limitations, which make it difficult to draw conclusions from our results on the actual impacts on energy and peak demand.

The research team interviewed managers at two of the sites to determine operator acceptance and to gather information on any productivity or other non-energy benefits from opportunity charging. However, of these two sites, only one had a possible need for opportunity charging but neither site changed its charging behavior to take advantage of this option. Apprehension over potential battery damage and a general reluctance to change their charging habits and risk impacting production appear to have been possible reasons.

Table 1. Summary of Prescriptive Offerings for HF Industrial Battery Chargers

Utility Program	States	Incentive
ComEd Energy Impact Illinois	IL	Up to \$230 per charger for newer technology industrial battery charger (minimum power conversion efficiency of 92% and minimum 8-hour shift operation five days per week). New charger must replace either a Ferro resonant or SCR charger.
Consumers Energy Business Energy Efficiency Programs	MI	\$350 per HF charger per shift.

Utility Program	States	Incentive
Energy Smart - C&I, offered to 20 Municipal Utilities in Michigan	MI	\$100 per HF charger per shift.
Missouri River Energy Services Bright Energy Solutions	IA, MN, ND, SD	\$100 per HF charger replacing FR or SCR charger (1 or 2 shifts fork lift operation). \$300 per HF charger replacing FR or SCR charger (24-hour forklift operation).
Northwestern Energy ePlus	MT	\$25 per unit for HF battery charger
PNM Commercial Energy Efficiency Rebate Program	NM	\$200 per unit for 3-Phase HF industrial battery charger

Many utilities currently offer custom incentives for HF industrial battery chargers (Table 1). Because of the limitations of this study, there is insufficient evidence from our findings alone to discontinue this practice, especially given the previous work by PG&E demonstrating significant energy savings on average for replacement of FR and SCR chargers. However, the PG&E results indicate significant variability in key energy efficiency metrics across each charger type. This suggests that HF chargers are not necessarily a cost-effective investment option for every business. Proposed installations should be carefully evaluated in relation to existing charger performance to ensure that minimum return on investment requirements will be achieved. If opportunity charging is desired, special consideration should be given to potential peak demand impacts as a result of the faster rate of charging.

Read the full report, [“Field Study of Industrial High Frequency Battery Chargers.”](#) In addition, a link to the recording of a webinar summarizing project outcomes is available on the [CARD Program Webinars and Videos](#) page of the Department’s website. For further information, contact project manager [Mark Garofano](#) or CARD program administrator [Mary Sue Lobenstein](#).

References

¹ US Census, 2011 *County Business Patterns*.

² *Pacific Gas and Electric Company (PG&E) Energy Technologies Program Application Assessment Report #0808: Industrial Battery Charger Energy Savings Opportunities*, Ecos Consulting. PG&E, San Francisco, CA: 2009.