



# Efficient Forklift Battery Charger

**If you are considering replacing your battery chargers, High Frequency is the best bet to minimize your energy use and costs.**

Forklift operation can consume a substantial amount of energy over time and is prevalent across many different types of facilities; therefore, facility operators can benefit from increasing forklift battery charger efficiency. The majority of facilities using electric forklifts currently power their batteries with chargers using Ferroresonant or Silicon Controlled Rectifier (SCR) technologies or with more recently developed Hybrid chargers, which combine a Ferroresonant transformer with SCR controls. However, new high frequency battery chargers potentially provide improved power conversion efficiency over all three of those technologies.

## Project Assessment

The PG&E Emerging Technology Group evaluated forklift battery chargers using a test procedure developed for assessing both small battery charger systems, (i.e. those in cell phones), and large charger systems, (i.e. those in golf carts and forklifts). Forklift battery charger tests were conducted at the PG&E Applied Technology Services Laboratory in San Ramon, California and at Southern California Edison's (SCE) Electric Vehicle Test Center in Pomona, California.

Experimenters measured energy efficiency using 28 battery chargers, which represented each of the four types of charger technology. Measurements were taken for several key indicators of efficiency:

**Charge return factor:** the ratio of energy supplied to the battery to energy delivered by the battery.

**Power conversion efficiency:** the ratio of AC power input from the grid converted to DC power delivered by the battery.

**Maintenance power:** charger power output when it is connected to a battery to compensate for discharge while not in use.

**No-battery power:** charger power consumption when plugged into the wall but not attached to a battery.

**Power factor:** the ratio of real power performing work to apparent power in an electrical system.



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## Results

High frequency chargers in the study had higher average power conversion efficiency, resulting from more efficient conversion of the AC power going into the charger to the DC power needed to charge the battery.

All four charger technologies showed a similar average charge return value. Charge return measures the amount of overcharging of a battery. Some overcharge is necessary to ensure battery health and life, but excessive overcharge is a waste of energy.

Charge return performance depends on a charger model's charge control circuitry and not on the type of technology used. There was more significant variation in charge return results among products within each technology type than between technology types.

Actual energy savings and simple payback time are dependent upon the number of forklifts in use and the total time they are used per shift and per day. Savings for a 3-shift operation range from 2,900 to 4,800 kWh/yr per charger, offering paybacks of one to three years on an incremental cost basis and four to six years on a full replacement cost basis. These savings are based on a comparison with an SCR or Ferroresonant charger.

## Average Forklift Charger Test Results

Technology		Charge Return Factor	Power Conversion Efficiency	Maintenance Power (W)	No Battery Power (W)	Power Factor
Ferroresonant	Range	1.12 - 1.21	84% - 87%	7.0 - 293.5	7.0 - 39.5	0.91 - 0.97
	Average	1.15	85%	81.7	18.2	0.92
SCR	Range	1.09 - 1.35	81% - 88%	10.0 - 262.8	10.0 - 285.0	0.60 - 0.85
	Average	1.18	85%	137.1	125.3	0.76
Hybrid	Range	1.10 - 1.14	80% - 89%	53.0 - 73.9	6.0 - 19.0	0.87 - 0.97
	Average	1.12	86%	62.3	14.1	0.91
High Frequency	Range	1.06 - 1.29	91% - 92%	23.8 - 108.0	23.8 - 108.0	0.93 - 0.9
	Average	1.15	92%	48.4	48.4	0.96

## Summary

We recommend purchasing one of the new high frequency products, if your battery chargers are due for replacement. Given the substantial savings potential and incentives that may be available through the Nonresidential Retrofit Program (NRR) or Nonresidential New Construction Program (NRNC) program, replacing older battery chargers before the end of their useful life may also be justified.

In addition to replacing battery chargers, customers can increase energy savings through battery management. Speak with your PG&E account representative about enrolling in a PG&E demand response program and scheduling battery charging for off-peak periods.

For more information on high frequency forklift battery chargers and other energy efficient emerging technologies, please visit [www.pge.com](http://www.pge.com), or call the **Business Customer Service Center** at **1-800-468-4743**.

