THE IMPACTS OF LIFT TRUCK POWER CHOICE ON PRODUCTIVITY AND PROFITABILITY IN WAREHOUSE AND DISTRIBUTION ENVIRONMENTS

RAYMOND

THE RAYMOND CORPORATION
GREENE, NEW YORK

EXECUTIVE SUMMARY

The Raymond Corporation conducted research that confirms converting a warehouse lift truck fleet power supply from traditional lead-acid batteries (LABs) to lithium-ion batteries (LIBs) results in an improvement in productivity by as much as 17% while providing a breakeven in 10 to 16 months with a lifetime return on investment (ROI) of 415% to 656%.

BACKGROUND

Warehouse and distribution operations have a range of power source options for lift truck fleets. While previous generations of lift trucks may have been limited to fossil-fuel or traditional lead-acid battery power, today's material handling equipment can also be powered by hydrogen fuel cells or a range of different batteries.

Modern warehouses and distribution facilities demand more from material handling equipment than simply the ability to move pallets; with e-commerce margins already very slim, every person and every piece of equipment should improve contributions to the bottom line if profitability and productivity are to be maintained. Choice of power source should be evaluated by its impact to overall productivity and its long-term ROI, not just its up-front cost.

The Raymond Corporation, working with the New York State Energy Research and Development Authority (NYSERDA), established a study intended, in part, to determine the feasibility and performance/profitability impact of LIBs in lift truck applications.

CHOICE DESCRIPTION

Today's warehouse managers have, in general, three choices in lift truck power supply: LABs, LIBs and hydrogen fuel cells.

While LABs have been in use for years in warehouse and distribution applications, these batteries require significant accommodations for charging, swapping, cleaning, watering and replacement — all of which require additional investment in time, space and manpower. In addition, equipment powered by LABs experiences performance declines as charge level drops, which results in the lift truck and operator becoming less productive over the course of a discharge cycle. Finally, efforts to improve LAB efficiency using fast-charge methods reduce battery life span when used in an opportunity-charging or a fast-charging environments; under these conditions, LABs with a standard five-year warranty may see their service lives reduced to only two years.

Although hydrogen fuel cells are attractive from an emissions and sustainability perspective, infrastructure and supply concerns can make the current generation of fuel cells impractical, especially for smaller facilities and companies.

LIBs, as an alternative, eliminate many concerns associated with both LABs and hydrogen fuel cells: Multiple LIB chemistries, each with unique performance attributes that can be matched to the application; use of LIBs eliminates the need for battery changing midshift; LIBs are virtually maintenance-free, requiring no watering, no annual washes and no equalizing; LABs may only offer a service life of 1,500 cycles, while most LIBs offer a minimum of 3,000 cycles (Raymond offers 3,500 or 5,000 cycles, depending on LIB type); LIBs perform at the same level regardless of the state of charge, so vehicles and operators experience no slowdown as state of charge drops; and LIBs charge faster than LABs and offer lower internal resistance, meaning less power is required from the utility provider and greater regeneration is captured, which leads to a more energy-efficient system.

After demonstrating the merits of the LIB solution, the only challenge may be high initial investment; but should that alone justify hesitation on the part of facility managers? This new technology requires a shift in mindset from the short-term acquisition cost mentality associated with LAB to a longer-term ROI approach for LIB.

LITHIUM-ION AS A SOLUTION

As part of a larger project completed in cooperation with NYSERDA, Raymond developed, tested and demonstrated a lithium iron phosphate (LFP) LIB system at a customer location and, based upon data collected, created detailed ROI models affirming the financial benefits of LIB adoption in appropriate scenarios.

The customer location was a food storage facility with both ambient and cold-temperature capabilities, which provided a good baseline for a traditional warehouse. The customer location would typically utilize LABs to a low state of charge and then swap the battery. Each battery swap required a trip to the battery room, removal of the spent LAB and insertion of a new fully charged LAB. The removed battery was charged, rested, watered and inspected prior to being used the next day. The time/effort required to maintain the LABs was compared with the time/effort required to maintain the LIB fleet utilizing opportunity-/fast-charging when the lift truck was not in use. The LIB-powered truck was integrated with the larger LAB-powered fleet for approximately three months to conduct this study; a five-week data set was used to provide the data for the LAB vs. LIB comparison.

KEY FINDINGS INCLUDE:

+ During the five-week period, the LAB was swapped 32 times, while the LIB completed the equivalent of 42 full discharge cycles without being removed from the lift truck.
+ In a typical discharge cycle, the LIB generated 0.7 kWh of heat, while the LAB generated an average of 1.4 kWh of heat — a load that would have noticeable impact on cold-temperature facilities.
+ Over the five-week period, both lift trucks moved approximately 4,000 pallets. The LAB truck required 216 operational hours, while the LIB truck only required 192 operational hours.
+ The LAB truck completed an average of 18 pallet moves per hour, while the LIB truck completed 21 moves — a 17% productivity improvement. This is attributed to the constant power performance of the LIB throughout the discharge cycle.

In addition to the 17% productivity improvement demonstrated during active operational time, the LIB was never removed from the lift truck, while the LAB required frequent trips to the battery room for changeouts and required the LAB-equipped truck to be navigated through pedestrian traffic en route to the battery room. Additional LIB benefits of the labor and time savings are not included in the 17% productivity improvement during operational time; however, they are considered in the ROI calculations presented below.

ROI ANALYSIS: TWO SCENARIOS

Several considerations factor into the overall cost benefit of using LIBs over LABs. To help quantify these benefits, Raymond developed two ROI models based on the performance of a LIB in typical applications. With properly implemented opportunity or fast charging, a replacement LIB can be sized significantly smaller than the LAB it is replacing. Under certain operating conditions, this can be as high as a 40% to 50% reduction in nameplate capacity. For example, a 1,000-ampere-hour (Ah) LAB could be replaced with a 500 to 600 Ah LIB. The lower capacity requirements offer an immediate savings and are incorporated into the ROI model calculations.

ROI Model 1: Single-truck Conversion. The first model calculates the total financial benefit of converting a single truck from LAB to LIB, instead of purchasing replacement LABs. This example assumes the lift truck is already in operation and the existing LABs have reached end of life and need to be replaced. In this hypothetical scenario, one LIB and one fast charger are purchased at the start of Year 1. For the LAB baseline, two LABs would be purchased at the start of Year 1, and again at the start of Year 4, based on a three-year life for a LAB. The inputs for labor savings due to reduced battery maintenance, elimination of battery changing and productivity improvements are based on the results of the LIB demonstration at the customer location mentioned above.

The incremental Year 1 capital investment to convert from LAB to LIB is $25,000; however, this is offset by the $19,000 annual labor savings realized from reduced maintenance, elimination of battery changing and the expected productivity improvements resulting from the use of LIBs. Additionally, the LABs will need to be replaced again in Year 4 (at a cost of $15,000), while the LIBs will typically last the full six years (or longer). This results in a breakeven (on the incremental $25,000 capital investment) of **under 16 months** and a cumulative net **savings of $104,000** over six years — a lifetime **ROI of 415%**.

LITHIUM BATTERY WITH OPPORTUNITY/FAST CHARGE							
YEAR	**1**	**2**	**3**	**4**	**5**	**6**	**TOTAL**
LAB Investment	$(15,000)	$0	$0	$(15,000)	$0	$0	$(30,000)
LIB Investment	$(40,000)	$0	$0	$0	$0	$0	$(40,000)
Labor Savings: Maintenance & Battery Changing	$4,099	$4,099	$4,099	$4,099	$4,099	$4,099	$24,594
Labor Savings: Productivity Gains	$14,875	$14,875	$14,875	$14,875	$14,875	$14,875	$89,250
Annual Financial Impact	**$(6,026)**	**$18,974**	**$18,974**	**$33,974**	**$18,974**	**$18,974**	**$103,844**
Cumulative Financial Impact	**$(6,026)**	**$12,948**	**$31,922**	**$65,896**	**$84,870**	**$103,844**	

Raymond used the following data from the customer test location:

+ 17% productivity improvement (increase in number of pallet movements per hour)
+ 12.5 minutes per battery change
+ One battery change per shift for LAB

Raymond made the following inputs and assumptions:

+ LAB investment: two @ $7,500 = $15,000
+ LIB investment: one @ $30,000 (battery) + $10,000 (charger) = $40,000
+ Two, eight-hour shifts per day
+ 250 operating days per year
+ $25 per hour fully burdened driver labor
+ $65 per hour fully burdened maintenance labor

LABs can be phased out on a truck-by-truck basis as the batteries reach end of life and are due for replacement. This allows the flexibility of implementing LIBs at a pace desired to the highest impact areas. By implementing the transition over several years, the initial investment in LIBs and opportunity/fast chargers are minimized; plus, the organization is able to socialize the technology and validate its value in each operational area prior to a complete fleet conversion or greenfield site build-out. Converting to LIB also can enable an organization that is operating at capacity to increase fleet capability without investing in additional lift trucks or expanding the battery maintenance and charging rooms.

ROI Model 2: New Fleet Purchase. The second model, using the same inputs and assumptions, evaluates the impact of implementing LIB when purchasing a new fleet of vehicles, such as for a new facility. This analysis uses a 50-truck, LAB, three-shift operation as the baseline. The LAB fleet consists of 50 lift trucks, 50 LABs and 50 opportunity/fast chargers. The LAB is charged in the lift truck and is not swapped as part of normal operations. Implementing LIB with opportunity/fast charging when the fleet is purchased allows for reduction or elimination of the battery room, as well as the purchase of fewer lift trucks due to increased productivity of LIB over LAB. This case uses more-conservative estimates for long-term productivity gains than were demonstrated in the field trial. A 10% (vs. 17%) increased productivity is assumed, which enables a fleet size reduction from 50 to 45 vehicles to accomplish the same amount of work. The fleetwide operator and maintenance labor are reduced correspondingly for the LIB fleet.

The incremental Year 1 capital investment to implement LIB vs. LAB is $700,000 (after accounting for the reduced fleet size); however, this is offset by the $820,000 annual labor savings realized from reduced maintenance, elimination of battery changing and the expected productivity improvements resulting from the use of LIBs. Additionally, the LABs will need to be replaced again at the start of Year 4 (at a cost of $375,000), while the LIBs will typically last the full six years, or longer. This results in a positive breakeven (on the incremental $700,000 capital investment) of **10 months**, a net **17% return in Year 1**, and a cumulative net **savings of $4,600,000**. This savings represents a lifetime **ROI of 656%** on the initial $700,000 incremental investment and a fleetwide **six-year cost reduction of 9%** compared with the baseline LAB fleet.

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	TOTAL
Capital Investment (LAB)	$3,125,000	$0	$0	$375,000	$0	$0	$3,500,000
Capital Investment (LIB)	$3,825,000	$0	$0	$0	$0	$0	$3,825,000
Capital Investment Delta (LAB - LIB)	$(700,000)	$0	$0	$375,000	$0	$0	$(325,000)
Labor Investment (LAB)	$7,878,000	$7,878,000	$7,878,000	$7,878,000	$7,878,000	$7,878,000	$47,268,000
Labor Investment (LIB)	$7,058,025	$7,058,025	$7,058,025	$7,058,025	$7,058,025	$7,058,025	$42,348,150
Labor Investment Delta (LAB - LIB)	$819,975	$819,975	$819,975	$819,975	$819,975	$819,975	$4,919,850
Annual SAVINGS Due to LIB	**$119,975**	**$819,975**	**$819,975**	**$1,194,975**	**$819,975**	**$819,975**	**$4,594,850**
Cumulative SAVINGS Due to LIB	**$119,975**	**$939,950**	**$1,759,925**	**$2,954,900**	**$3,774,875**	**$4,594,850**	

The two ROI case studies confirm both the short- and long-term financial benefits of LIB. These case studies should be used for general guidance only. Interested parties should contact Raymond directly to develop ROI models for their specific applications.

THE RAYMOND ADVANTAGE

Among all the technical details of material handling equipment and power sources, one factor critical to the success of any facility transformation or process improvement effort is frequently overlooked: the choice of intralogistics partner.

From award-winning material handling equipment to batteries and chargers to some of the industry's most powerful telematics, Raymond delivers end-to-end solutions that address the unique needs of a customer's facility and labor force:

+ Raymond sales and service consultants work to understand customer processes and challenges and to design systems that transform the facility into a model of efficiency, productivity and data gathering.
+ Raymond offers premium LIB products in both primary categories of chemistry — lithium iron phosphate and nickel manganese cobalt — allowing Raymond to more closely match battery performance to the customer application.
+ Raymond LIBs are specifically designed to match and enhance the performance characteristics of Raymond® lift trucks. Used in combination with Raymond's telematics applications, Raymond LIBs also enable extensive data gathering — giving facility managers powerful insight into battery and equipment performance.
+ In addition, Raymond products are sold and serviced by a nationwide network of factory-trained consultants and technicians, meaning customers can be assured of fast, professional support.

As a global leader in intralogistics equipment and services, Raymond can recommend, design and implement a wide range of solutions to help achieve customers' specific goals. To learn more about the entire Raymond portfolio or to find your nearest Raymond Solutions and Support Center, visit raymondcorp.com.

RUN BETTER. MANAGE SMARTER.®

At Raymond, our aim is to deliver the utmost quality and to work for continuous improvement every day, in every aspect of our business. We are proud of what we build. We are proud of the level of service we provide to keep our customers' business up and running. We take pride in our commitment to our customers through our end-to-end approach in helping them find smarter, more efficient and more effective solutions.

We value the trust that Raymond has earned through decades of proven performance and hands-on innovation. Since the patenting of the first hand-pallet truck to the invention of the reach truck to our pioneering work in narrow aisle operations and beyond, Raymond has led the way in providing customers with the tools and expertise to improve their business.

IF YOU'RE LOOKING FOR A PARTNER WITH THE TOOLS AND EXPERIENCE TO HELP YOU RUN BETTER AND MANAGE SMARTER, LET'S TALK.

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