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Airport Electrification Strategy at the Los Angeles International Airport

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Technical Report, October 2008

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REPORT SUMMARY

In an era of rapidly increasing fuel costs, airlines are struggling to control their expenses. Switching from diesel or gasoline powered ground support equipment (GSE) at airports is one possible option, but a capital outlay necessary to make the transition often causes projects to stall in the financial approval process. This report provides a case study that summarizes of current efforts and future opportunities to electrify airport equipment at Los Angeles International Airport (LAX), identifies the obstacles to going electric, and develops a strategy to overcome these impediments.

Background

Airports are typically located in metropolitan areas with strict air quality standards and non-attainment issues. To meet local standards, airports and airlines in the United States are beginning to focus on the reduction of ground support equipment emissions. The most common solution is to replace existing diesel and gasoline powered ground support equipment (GSE) with battery-powered electric alternatives. Los Angeles International Airport (LAX), a leader in the development and use of alternative fuel vehicles, is an ideal place to formulate a strategy and case study for GSE electrification. EPRI together with Los Angeles Department of Water & Power (LADWP) are investigating the opportunities and challenges of GSE electrification at LAX in order to provide model that can be used as a reference by other airports.

Objectives

To develop a strategy to assist airlines and ground handlers in introducing or expanding electrification of GSE at LAX.

Approach

The project team investigated the history of the use of GSE at airports and weighed the benefits of gas versus electric GSE in these venues. The team reviewed the status and prospects of fast charging, a relatively new technology that was developed in the mid 90s as an alternative to conventional charging methods and battery changing. They described the current status of GSE at LAX, including electrification programs already in place with seven airlines and the prospects for expanded use of electric GSE. The team explored the possible use of alternative sources of power to provide electricity to existing and future electric GSE and made recommendations for more easily and affordably using electric GSE through infrastructure improvements and other measures.

Results

Electric GSE is easier to maintain; more reliable; and, above all, much cheaper to run—an electric baggage tractor can be operated for less than $9.00 a day while the average internal combustion baggage tractor has a daily cost of operation of $20 or more. Electric GSE has other advantages, including quiet, emission-free operation and improved safety. The limited capacity of the battery pack and the down time for charging associated with electric vehicles has been a drawback in the past, but the advent of fast charging has allowed airlines to expand the role of electric vehicles at airports.

LAX has been one of the leaders in the history of electrification of airport GSE. Seven airlines already operate electric GSE there, and the prospects are favorable for the large airlines to electrify most of their ground support equipment and thus make a major contribution to the reduction of emissions at LAX while realizing significant economies for themselves.

While converting internal combustion GSE to electric will help reduce emissions sources at LAX, it will not completely eliminate the green house gasses and other emission relating to the generation of electricity. To reach a true zero or near zero emission impact, renewable sources of power should be considered as part of the strategy to power the infrastructure for the electric GSE. One of the best choices for renewable energy in Southern California is solar; but small, efficient wind turbines and wave power generation from the nearby ocean may be feasible options for LAX.

EPRI Perspective

The airlines are facing some of the most difficult challenges of their history. With oil at near-record prices per barrel, it takes a great opportunity to get the airlines to shift their focus from fuel and cost mitigation to strategic technology implementation. While electric vehicles have a great financial story to tell on their own, the upfront cash outlay often causes projects to stall in the financial approval process. Any assistance from the airports, utilities, Federal Aviation Administration (FAA), or other regulatory agencies may tip the scale in favor of electrification and the benefits all stakeholders receive due to the improved efficiency of electric GSE.

Keywords

Airports
Ground support equipment
Infrastructure
Fast charging
Emissions
Electric vehicles

ABSTRACT

In an era of rapidly increasing fuel costs, airlines are struggling to control their expenses. Switching from diesel or gasoline powered ground support equipment (GSE) at airports is an attractive option for airlines to save money on fuel and reduced maintenance costs. Los Angeles International Airport (LAX), a leader in the development and use of alternative fuel vehicles, is an ideal place to formulate a strategy and case study for GSE electrification. EPRI together with Los Angeles Department of Water & Power (LADWP) are investigating the opportunities and challenges of GSE electrification at LAX in order to provide a model that can be used at other airports. This report summarizes the cost and other advantages of electric GSE relative to diesel or gasoline powered GSE. It describes the current status of GSE at LAX, including electrification programs already in place with seven airlines, opportunities for expansion of the use of GSE, and prospects for the use of alternative sources of power to provide nonpolluting electricity to existing and future electric GSE. Recommendations are made for encouraging the wider use of electric GSE through infrastructure improvements and other measures.

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1 INTRODUCTION

Background

Airports are typically located in metropolitan areas with strict air quality standards and non-attainment issues. To meet local standards, Airports and Airlines in the United States are beginning to focus on the reduction of ground support equipment emissions. The most common solution is to replace existing diesel and gasoline powered ground support equipment (GSE) with battery-powered electric alternatives.

Additionally, are the economic benefits to replacing an internal combustion fleet with electric alternatives. Reduced maintenance and reduction in the cost of fuel make the life cycle costs significantly less than the average diesel and gasoline-powered counterpart.

Los Angeles International Airport (LAX), being a leader in the development and use of alternative fuel vehicle is an ideal place to formulate a strategy and case study for GSE electrification. EPRI together with Los Angeles Department of Water & Power (LADWP) are investigating the opportunities and challenges of GSE electrification at LAX with the intent to establish a model that can be a reference to other area airports.

Objective

Develop a strategy to assist airlines and ground handlers in introducing or expanding electrification of GSE at LAX. This strategy will include a summary of current activities and identify opportunities to electrify airport equipment. The strategy will also identify potential obstacles to going electric and some of the solutions that have been used to overcome those obstacles.

Goal

This strategy will be used to help EPRI, LADWP and LAX understand the resources required to assist the operators at LAX in their effort to utilize more electric equipment. The end result should be the formation of a cooperative committee at LAX made up of Airlines, Ground Handlers, Airport Management and LADWP. That committee would be the conduit for LAX and LADWP to fully understand the needs of the operators, and for the Airlines and Ground Handlers to request certain projects to meet the common goal of GSE electrification.

2
ELECTRIC GROUND SUPPORT EQUIPMENT

History

The concept of battery powered vehicles dates back to the beginning of the automobile. When the internal combustion engine was first invented, there was a shortage of fuel to power the vehicles. In addition, internal combustion engines at the time required the driver to hand crank the engine to start. Drivers, especially female, found it difficult and dangerous cranking the engine to life. In that era, battery powered cars were as prevalent as any other powered vehicle on the road.

Ironically, it was the invention of the starter motor that killed the electric car. The battery powered starter motor eliminated the hand crank, leaving consumers with fuel cost as the only reason not to purchase electric. When large amounts of Oil were discovered in Pennsylvania, New York and Texas, the access to inexpensive fuel eliminated the interest in the more expensive and limited range of the battery powered electric vehicles.

Electric GSE began in the 70's with Eastern Airlines and the Kersey electric Aircraft Tractor. An aircraft tractor requires a significant weight to gain a mechanical advantage over the airplane it must move. That weight is most commonly steel and lead. Early designers theorized that instead of ballasting the tractors with raw lead, they could use flooded-lead acid batteries and use the energy to propel the tractors. Shortly after the success of the Kersey, Pettybone and Lansing introduced electric baggage tractors to the GSE industry with limited roll out by Eastern, Air Wisconsin and Delta Airlines. Tug introduced the ME-30 a short time later which was used by United in Chicago and Delta in Atlanta.

In 1991 with the invasion of Kuwait and the high fuel prices that followed drove car manufactures to renew their investigation into electric vehicles. General motors introduced the EV1, the first production electric car, and Toyota intruded the electric Rav4, the first production electric SUV in the mid 90's. Once again the low cost of fuel in the late 90's and perceived limitations of battery power returned the electric car to the history books. Different this time though was that the airlines continued push to develop efficient electric GSE even after gas prices retreated after the war.

American Airlines and United continued to lead the charge to electrify their GSE fleets through the late 90's. American partnered with Charlatte and United partnered with Toyota for electric vehicles. Throughout the 90's both airlines grew their electric fleets at large stations on the west coast and hubs city in Dallas, Chicago, Washington, and New York. Fleet sizes grew from just few hundred in the mid 90's to close to three thousand vehicles by early 2000.

The second gulf war and the resurgence in gas prices as shifted the focus of consumers to alternative power. Additionally, the reduction of harmful emissions is driving the continued electrification of GSE. In 2000, the State of Texas signed a State Implementation Program (Texas SIP) with the airports and carriers to reduce emissions in non-attainment cities in Texas. Later that same year the Airlines and the South Coast Air Resources Board of the State of California began negotiations on a similar program the California Memorandum of Understanding. (Cal MOU).

Benefits of Electric GSE

Electric GSE has three main cost benefits. They are detailed in the following sections.

Maintenance

Electric vehicles are much less expensive to maintain than their internal combustion counterparts. Internal combustion engines have several large components made up of many moving parts that must function together to turn chemical energy into mechanical energy. Each one of those parts requires constant lubrication to dissipate heat energy that is produced as a byproduct of combustion and friction. Each one of those moving parts must be maintained, and a stock of replacement parts must be kept in the event of failure.

In contrast, an electric vehicle converts chemical energy into mechanical energy with one moving part, the motor. Electric vehicles extract the chemical energy from the battery in the form of electricity. The electricity passes through a system of controls and is sent to the motor for conversion to mechanical energy. Most electric motors dissipate their heat energy through a simple heat exchanger or “air cooled” system of vanes and airflow. The maintenance of an electric motor is simple lubrication for AC motors and brush maintenance for DC motors.

The process of converting chemical energy into mechanical energy is one of the most efficient power processes. An electric battery and motor combination captures and utilizes about 90% of the available energy to generate motion. A gas powered internal combustion engine is only about 25% efficient in capturing and using the energy in its fuel source. Efficiency can be directly equated to a vehicles maintenance cost and reliability. Inefficiency produces heat; heat and friction are the principal causes of failure of most mechanical systems. Heat is such a problem in internal combustion engines, that they have a whole subsystems dedicated to removing excess heat energy from those moving parts. If that system fails, the engine experiences a catastrophic failure.

Reliability

The reliability of GSE is best explained as the ability of the vehicle to perform the task it was intended for at the time it is required. The reliability of an internal combustion engine is based on the coordinated interaction of all the subsystems required to generate combustion. Ironically, with internal combustion GSE, one of the most unreliable components is the electric starter and battery. Internal combustion engines are increasingly unreliable in extreme temperatures and under extreme stresses.

An electric powered vehicle in contrast has a great record for being reliable in a range conditions. The reliability of an electric is two fold. First, due to less maintenance the vehicle is out in the operation for longer periods between scheduled maintenance visits. Second, the electric vehicle is optimized to operate in varied conditions. Electric vehicles have fewer limitations than internal combustion in extreme cold and perform equally in extreme heat.

Fuel

The final and most obvious benefit of electric equipment is fuel savings. To accurately compare the cost of fuel for an electric versus internal combustion GSE, several factors need to be considered. First, the cost of the electricity; second, the cost of the fuel storage or battery; Third the efficiency of the charger that takes the grid power and puts it into the battery.

Grid power is the easiest cost to analyze. With a simple utilization meter, a fleet manager can discover the amount of power that an electric vehicle is consuming while performing daily duties. That power is measured in kilowatts. Electrical power from the grid is measured in kilowatt hours, our 1 kilowatt of power for 1 hour. Once kilowatt hours are established, it is easy to calculate the cost of power by simply multiplying by the cost per kilowatt hour. See Figure 2-1 (Example 1).

Electric GSE is most commonly powered by lead-acid batteries. Other common battery types include Gel-cell and Absorbent Glass Mat chemistries. The battery should be considered as a cost component of fuel because it is a consumable with a shelf life. In fact when calculating the cost of electric GSE, some airlines capitalize the battery over its useful life and assign that daily cost as a portion of the fuel cost analysis. Other airlines consider the first battery as part of the acquisition cost of the vehicle and subsequent batteries as maintenance cost.

The final component of the fuel calculation is efficiency. Electricity from the grid is AC power, and can not be put into the battery without conversion to DC power. The function of converting the power from AC to DC and delivering in the right amount of voltage to the battery is the function of the charger. There are two principle types of chargers in use at Airports, Conventional chargers and Fast Chargers. Each type of charger has an efficiency rating that basically defines the amount of incoming power that is transferred to the battery. This rating can vary from 65% at the low end all the way up to 95% efficient with some of the new high-tech chargers. This large variation is why it is critical component in calculating the cost of fuel.

Example 1
Fuel calculation model:

The average baggage tractor uses an 80 volt 500 AH battery.

- The battery costs about $6,500
- The useful life of the battery is about 5 years
- The daily utilization cost of the battery is $6,500/1825 days = $3.56

The average baggage tractor consumes between 30 and 35 kWh of electricity daily.

- At $0.10 per kWh, that equals about $3.50 per day at 100% efficiency.
- At 90% efficiency that cost increase to $3.85 per Day
- At 65% efficiency that cost jumps to 4.73 per day

The total average fuel cost for an electric baggage tractor is the sum of the two categories.

- At 90% efficiency, the daily cost would be $7.41
- At 65% efficiency, the daily cost would be $8.29

The average internal combustion baggage tractor burns between 6 and 8 gallons of fuel per day.

- At $3.30 per gallon that daily cost of operation is $19.80 to $26.40

Figure 2-1
Example 1, Fuel Calculation Model

Additional Benefits of Electric GSE

There are several non-cost benefits of electric vehicles. The most obvious benefit of electric vehicles is the elimination of harmful combustion gasses both for the general environment and for the health of the operator. Electric vehicles are much quieter than internal combustion engines reducing the noise and potential hearing damage of the operator. The ability to electronically control the speed of electric vehicles increases vehicle safety by preventing operators from exceeding the speed limits set by the airport. Regenerative braking, the act of using the motor as a generator, not only recaptures the inertia of the vehicle to charge the battery it also acts as an additional brake and increases safety factors. The electric vehicle offers many cost and non-cost benefits, most of which revolve around reducing risk and cost and improved safety for the operator.

Electric Challenges

The limitation of electric vehicles has always been the capacity of the battery pack and the down time for charging. A standard tug with an average sized battery should be able to run for a shift depending on the size of the airport and the number of flight per day. With conventional charging, that tug was then required to park and charge for 6 to 8 hours. This limitation effectively restricted the use of electric vehicles to gate areas and light duty operations. Some Airlines have tried to overcome this shortfall by adding larger batteries, but that brings additional problems due to the extra weight and vehicle stresses. It wasn't until the introduction of fast charging that electric vehicles could perform the duty cycle that the airlines required to make electric viable. Overcoming the challenge of down time by fast charging batteries has allowed airlines to expand the role of electric vehicles at airports.

Evaluation of Gas versus Electric GSE

With the rising cost of fuel and the pressure from regulatory agencies to reduce emissions, maybe it is time to reevaluate the cost of converting to an electric GSE fleet. The transition to electric though costly in the initial outlay of capital dollars can bring immediate savings to operational budgets. When planned and implemented correctly, the benefits of electrical equipment can also be seen in both cash and non-cash savings.

Vehicle Types

Currently the most economical vehicles to electrify are Bag Tugs, Beltloaders, Narrow-body Aircraft Tractors, and Passenger Stairs. Add to that list, FMC's Container loader and TLD's Wide-Body Aircraft Tractor, that are currently under development and testing for operators of Wide-body fleets.

The easiest GSE fleet to electricity is the gate tractor and the beltloader. There are many vehicles available to fill these roles from Charlatte, Tug, TLD, Harlan, Toyota and others, and have been in successful operation for over a decade. These vehicles, when coupled with Fast Charging can maintain duty cycles equivalent to their internal combustion counterparts.

Cost of Vehicles

The up-front cost of electric vehicles on average is about 30 to 35 percent more expensive than their gas counterparts. If the decision to convert to electric is made purely based on the initial cost, then it would not make sense to convert, but the true savings comes in the operation of electric vehicles.

Cost of Infrastructure

In addition to the higher initial cost, electric vehicles also require charging infrastructure. This infrastructure is actually much less expensive that the corresponding infrastructure required to deliver gas to the airport, but since the gas infrastructure is already available at airports, that cost is rarely considered.

Charging infrastructure can be expensive at an airport with little power available, but there are new ways of extracting power for charging without the need for costly infrastructure upgrades.

Cost of the Fuel

Fuel is the single most volatile cost in operating a gas fleet. In the last 3 years fuel has been as low as $1.20 per gallon and as high as $3.35 per gallon. In the same time period, industrial electricity has averaged between 6.5 and 8 cents per kilowatt-hour.

The fuel cost to operate an average gas baggage tractor is about $13 per day. That assumes an average tractor runs 3.75 hours per day and consumes fuel at a rate of 1.5 gallons per hour and fuel costs $2.30 per gallon.

An electric vehicle with the same duty cycle consumes between 27.75 and 33.5 kilowatts, or $2.10 to $2.50 per day. To make a fair comparison, the price of the battery must be calculated, as it is part of the fuel system of an electric vehicle. Assuming a battery that costs $6000 and lasts 5 years amortized over the life would cost $3.29 per day. Adding the cost of the battery into the daily fuel cost equates to between $5.39 and $5.79 per day. That is a savings of between $7.21 and $7.61 per day.

Cost of Maintenance

There is a big debate in the airline industry about the cost savings of operating an electric fleet over a gas fleet. The basis of this debate comes down to the way maintenance is calculated. Most airlines calculate the cost of maintenance on a vehicle as “cost per hour of operation.” Most electric fleet operators will agree that the cost of maintenance per hour is as much or slightly higher for an electric than a gas.

When comparing gas and electric fleets, the cost per hour calculation is not a true comparison. Hours on a gas vehicle are measured as the motor is running. Hours on an electric vehicle are measured when the vehicle is actually moving or working. The difference between the two is idle time. An hour meter on a gas unit runs the entire time the unit is idling. The difference can be as much as 65 – 70 percent.

Consider the example above. The gas unit runs for 3.75 hour per day on average. The electric unit only operates for 1.3 to 1.9 hours, but accomplishes the same tasks. Therefore if you consider the cost per hour of a gas to be equal to the cost per hour of an electric, you will achieve 65 to 70 percent more work for the same amount of maintenance. Additionally, if Maintenance is scheduled by hours, a gas unit is maintained almost 2.5 times more often than an electric.

Total Cost of Ownership

As illustrated above, the initial cost cannot be the only determining factor when choosing an electric fleet over a gas fleet. To make the best fleet decision, one must consider the Total Cost of Ownership. In the case of a baggage tractor with a useful life of 15 years, the estimated fuel savings alone will be over $40,000 factoring in new batteries every 5 years. If maintenance costs an average of $2,000 per year for a gas unit, over the life of an electric the savings would add up to $18,000. Over the life of a tractor that is an annualized savings of $3,866 per year per unit.

The following table is a simple model to calculate Total Cost of Ownership of both gas and electric vehicles.

Table 2-1
Cost of Ownership for Gas and Electric GSE

	Gas Vehicle	**Electric Vehicle**
Initial Cost	X	X+35%
Cost of fuel per day	A	B
Battery cost per day	None	C
Maintenance cost per hour	Y	Y+2%
Daily hour usage	Z	Z-65%
Charger Cost	None	$8,000
Expected life	15 Years (5,475 days)	15 Years (5,475 days)
Total Cost of Ownership	X+(A x 5475)+(Y(Z x 5475)	(X x 1.35)+(B+C(5475)) +((Yx1.02)(Z x .35)5475)+8000

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FAST CHARGING TECHNOLOGY

Fast Charging is a relatively new technology that was developed in the mid 90's as an alternative to conventional charging methods and battery changing. Fast charging applies far more power to the battery in a shorter amount of time than conventional charging. In order to safely apply additional power to the battery, the fast charger must know the parameters of the battery it is charging, as well as receiving real-time feed back from the battery during the charge. The real-time feedback is critical to completing a fast charge in a safe manner and ensuring that no damage is being done to the battery during charge.

There are two manufacturers of battery chargers that produce fast chargers for the airline application, ETEC and PosiCharge. Each of these charging systems employs a unique methodology to achieve the same result. ETEC employs a technology called pulse charging to charge the battery and then measure its response to the charge. PosiCharge uses a constant current method that relies on an intelligent module on the battery to deliver feedback from the battery to the charger. While there are advantages and disadvantages to each method, both chargers deliver the right amount power to charge the batteries quickly and without damage.

The measure of a fast charger is in its ability to charge a battery quickly. Usually fast charging is broken down into 3 levels: Quick charge, opportunity charge, Fast charge. The amount of time it takes to charge a battery as compared to a conventional charger is as follows. A quick charge is usually about half the time of a conventional charge. A fast charge is usually about a quarter of the time of conventional. An opportunity charger is set-up to charge when ever the vehicle has a break in its duty cycle.

With the technology of fast charging comes a level of intelligence required to make the charge function correctly. This intelligence in a charging system allowed the chargers to take over some of the manual functions of charging and automate them. Functions such as equalization that once required user input, are now automatic. In addition, if equalization is interrupted, the chargers know to restart the equalization once the battery is returned to the charger. This level of automation has helped the airline industry embrace electric vehicles more so now than before fast charging was available. Conditions on the ramp are more conducive to an automated system rather than a manual one as users do not always operate the same vehicle for their entire shift as in other industries. If the charger manages and records all of the functions related to battery charging, it is one less task that has to be managed by the users.

AeroVironment PosiCharge

AeroVironment's PosiCharge division has been producing chargers for the Airline business for nearly 10 years. They started with a proof of concept with Delta Air Lines in conjunction with a University of Georgia study. From there the full production chargers were first installed at American Airlines in DFW and Continental Airlines at LAX. From the first installation to present day they have installed over 1700 fast chargers at airport all around the world.

At the heart of the PosiCharge technology is a distributed energy concept. The majority of the PosiChargers at airports are multi-port system meaning one power source can charge multiple vehicles. The advantage of distributed energy chargers lies in their ability to prioritize the available power and deliver the right amount of energy to the vehicles based on their individual states of charge. In this manner 10-port charger uses the same amount of energy as 4 conventional chargers, but is able to distribute that energy efficiently over 10 vehicles instead of 4 and charge them in a quarter of the time.

Figure 3-1
Multi-Port PosiCharge System

ETEC

Incorporated in Phoenix, Arizona in 1996 to support the development and installation of battery charging infrastructures for electric vehicles, Electric Transportation Engineering Corporation (eTec), a wholly-owned subsidiary of ECOtality (OTC BB: ETLY), is a recognized leader in the research, development and testing of advanced transportation and energy systems. Specializing in alternative-fuel, hybrid and electric vehicles and infrastructures, eTec is committed to developing and commercially advancing clean electric technologies with clear market advantages.

eTec's flagship product, the eTec Minit-Charger™ - fast battery charging system designed for electric vehicles, airport ground support equipment and material handling applications - allow for faster charging with less heat generation and longer battery life than conventional chargers.

4
LOS ANGELES INTERNATIONAL AIRPORT

Introduction

Los Angeles International Airport, or more commonly know by it's airport code, LAX, is situated less than ½ a mile from the Pacific Ocean and right in the middle of one of the most renowned non-attainment areas in the country, the Los Angeles-South Coast Air Basin. LAX airport is the fifth busiest airport in the world with 575,200 flights carrying 61 Million passengers last year alone.

LAX is one of the most diverse hub airports in the United States. Domestically, most hub airports are dominated by a single carrier, but LAX shares dominance between three airlines; American, Southwest and United. Given the diversity at LAX, there is not one carrier that dominates airport operations due to their size, this gives LAX a rare opportunity to build consensus among competing airlines when making plans for future airport development.

Figure 4-1
LAX Control Tower and Theme Building

LAX Airport is a compact airport with 9-passenger terminal built in a U shaped configuration. Each of the larger airlines operates their own terminals while the smaller airlines and marketing partners share terminal space in the larger northern terminals. The Tom Bradley Terminal houses most of the International carriers with 11 gate spaces around the terminal and 15 remote stands on the west side of the airport.

Figure 4-2
Map of LAX Terminals

This compact structure lends itself well to the use of electric vehicles for operations around the gate areas and in between terminals. The longest distance that a vehicle has to travel from baggage pick-up to aircraft is less than 400 yards.

Aircraft diversity is another unique feature of LAX. LAX accepts some of the smallest regional aircraft for connections to small cities around Southern California, and in the very near future, LAX will host the largest passenger aircraft, the A380 which will initially be flown in by Qantas from Australia. The diversity in jet size from the smallest to the very largest and every thing in between makes LAX an ideal case study for electrics in various operation situations.

From its humble beginning in 1928 to fifth largest airport in the world and every milestone in between, LAX has been a landmark and cornerstone for the aviation industry.

Figure 4-3
LAX in 1929

Figure 4-4
SST Visit

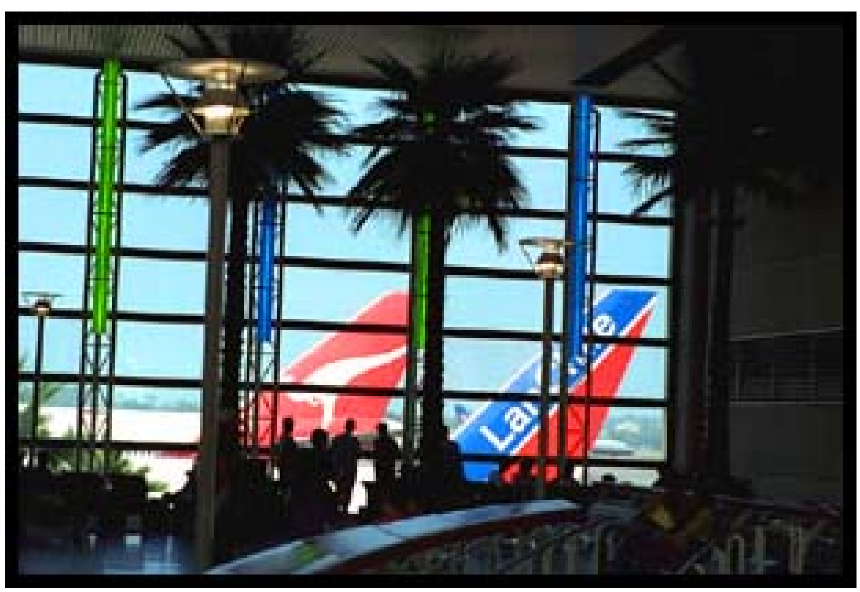

Figure 4-5
LAX Terminal View

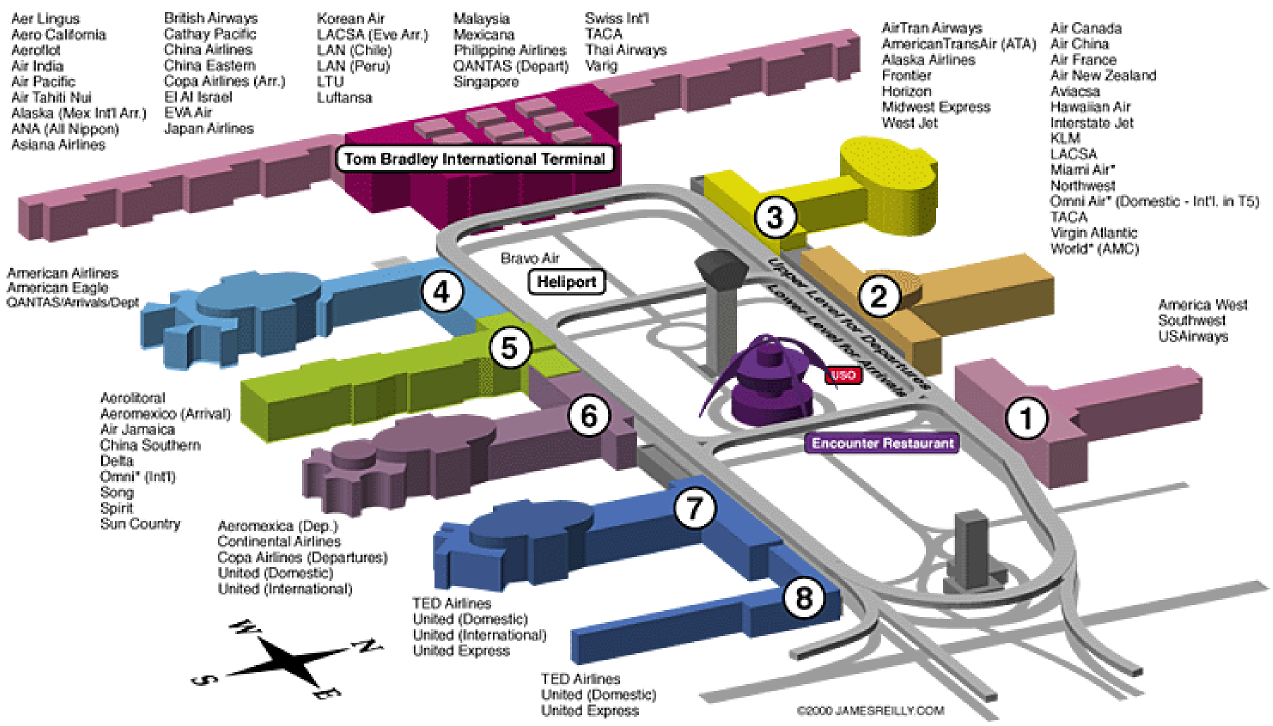

Figure 4-6
Map of LAX Terminals

Electric Ground Support Equipment

Current Fleet

The current ground support fleet in operation at LAX is widely diverse. The larger airline operations use a mixture of Gas, Diesel, CNG and some electric. The international and some of smaller airlines outsource their ground services to Ground Handlers such as Menzies, ASIG, Swissport and Evergreen. Some of these ground handlers have several contracts throughout the airport and their GSE fleet size rivals some of the larger carriers in size. Any analysis of the fleets at LAX must consider the diversity of both of these operational situations, and the impact of asking them to change their fleets.

Baggage Tractor

The baggage tractor is the most diverse piece of equipment used on an airport. A baggage tractor usually has the capacity to tow between 15 to 17 tons. This tractor is used primarily to pull trains of baggage carts from the bag room to the aircraft and back to the bag room. In some hub applications, the baggage tractor is utilized to move baggage from an arriving aircraft directly to a departing aircraft for passengers connecting to another flight on the same carrier. This function is commonly referred to as quick transfer bags or online transfer. The bag tractor can also be used to stage other pieces of equipment around the aircraft such as Airstart Start Units (ASU) and Ground Power Units (GPU). Baggage tractors can be powered by gas, diesel, propane, CNG or electricity.

Figure 4-7
Baggage Tractor

Table 4-1
Baggage Tractor Electric Options

Manufacturers	Models
Tug	MA, MH-50, MX4
Charlatte	t-135, t-137, t-208
Harlan	HTA, HLP, THE
Toyota	TG, TD
NMC Wollard	Model 60, 100

Belt Loader

A belt loader is a mobile conveyor that the airlines use to load baggage and bulk-load cargo into the belly of an aircraft. The unit is self-propelled and is able to lift up to 2000 lbs of baggage and cargo from ramp level up to the lower door of the aircraft. Belt loaders can be powered by gas, diesel, CNG or electricity.

Figure 4-8
Belt Loader

Table 4-2
Belt Loader Options

Manufacturers	Models
Tug	660, 660E, 440E
Charlatte	CBL 2000e, CBL 100e
NMC Wollard	TC 888
TLD	NBL

Aircraft Tractors

Aircraft tractors are the large vehicles used to move aircraft when they are not under their own power. Aircraft tractors can be used as gate tractors or maintenance tow tractors. Gate tractors are used only in the gate areas to bring planes into a gate and push them out once they are loaded. Maintenance tow tractors are used to position aircraft in remote parking areas and to move aircraft from maintenance hangars to the gate. Maintenance tow tractors are usually larger tractors and require significantly larger engines to move aircraft over long distances.

These two groups can be further broken down into two categories: Conventional Tractors and Towbarless Tractors. Conventional aircraft tractors use a towbar to connect to the nose gear of an aircraft in order to move the plane around. Towbarless tractors do not require the use of a towbar as they grab the nose gear in a cradle and lift it off the ground to move the plane.

Aircraft tractors are usually powered by large diesel engines, but some smaller narrow-body tractors can be powered by gas, CNG or electricity.

Figure 4-9
Towbarless Tractor

Figure 4-10
Conventional Tractor with Towbar (yellow)

Table 4-3
Aircraft Tractor Options

Manufacturers	Models
Tug	GT-35, Gt-50, GT-110
Charlatte	TPX 100e, TPX 200, TPX 500
FMC	B-350, B-600, B-1200
Goldhofer	AST-1, AST-2

Lavatory Service

Lavatory service trucks add sanitary fluid to and remove waste from the aircraft. From the aircraft, these trucks transport the waste to a common disposal area within the airport. In most cases, the disposal area is close to the aircraft operations area. Lav trucks can be powered by gas, diesel, CNG and electricity.

Figure 4-11
Lavatory Service Truck

Table 4-4
Lavatory Service Options

Manufacturers	Models
Charlatte	CLT100
NMC Wollard	TLS-770
TLD	LSP-900

Container Loader

Container loaders load cargo containers into the aircraft cargo areas. Container loaders come in two basic sizes; upper deck loaders and lower deck loaders. Upper deck loaders are used to load cargo into the upper deck of an aircraft, and are only used on Cargo aircraft. Upper deck loaders are usually rated for loads up to 30 tons. Lower deck loaders are used to load cargo containers into the lower deck of both passenger and cargo aircraft. Lower deck loaders are rated for loads up to 71/2 tons. Container loaders are usually powered by diesel engines, but they can also be powered by gas. An electric lower deck loader was made and tested by FMC with Delta in Orlando.

Figure 4-12
Container Loader

Table 4-5
Container Loader Options

Manufacturers	Models
FMC	Commander 15, 30, 60
TLD	828, 929

Air Conditioning Unit

A/C units are used to cool the aircraft while they are on the ground. There are three general sizes of A/C units at the airport 30, 60, 110 tons. The 30 ton units are used for narrow-body aircraft, the 60 ton units are used for the larger narrow-body into the smaller wide body aircraft like the 757 and 767 respectively. The 110 ton units are used for the large wide-body aircraft like the 777 and 747. At LAX most A/C units are mounted underneath the jet bridges and run on electricity from the grid. There are various mobile A/C units at the airport that are used at some gates, or for cooling aircraft at remote pad operations. Many of the cargo carriers use mobile A/C units as they do not have the electric infrastructure to support A/C units on the ramp. Mobile A/C units are powered by large diesel engines, and their duty cycle is such that diesel engines are the only viable technology at this time.

Figure 4-13
AC Unit

Table 4-6
AC Unit

Manufacturers	Models
Trilectron	DAC-20, 30, 90
TLD	Ace-302, 802, 804
FMC	JetAire-30, 90

Ground Power Units

Ground Power Units (GPU) are used to power the electrical systems on the aircraft while it is parked on the ground. The power that a jet uses is very different from standard grid power. Standard grid power is 60 hertz, while aircraft require electricity at 400 hertz. At LAX, almost every jetbridge has a GPU to provide power to the aircraft eliminating the need to have a mobile generator supply the aircraft with power. At LAX, these units are only used for remote airline operations, and cargo carriers.

Figure 4-14
Ground Power Unit

Table 4-7
Ground Power Unit Options

Manufacturers	Models
Trilectron	90C400LN, 120C400LN
TLD	GPU-4000
TUG	GP-400-100, 120, 140

Airstart Unit

Airstart units are large continuous flow air compressors used to start jet engines. These compressors deliver between 150 and 300 pounds of compressed air to the jet engine to spin the turbine during the start sequence. Airstart units are exclusively powered by large diesel engines, and due to the duty cycle and the critical function of starting a jet engine, their is no alternative technology available today. It is interesting to note that the new 787 from Boeing will have electric starter motors for the main engines, eliminating the need for an airstart on this aircraft. It is also likely that most future aircraft types will also use electrical starter motors. It is possible to see this type of equipment phased out over time.

Figure 4-15
Airstart Unit

Table 4-8
Airstart Unit Options

Manufacturers	Models
Trilectron	90C400LN, 120C400LN
TLD	GPU-4000
TUG	TMD 150/180, 250, 400

Electrification Programs

LAX has been one of the leaders in the history of electrification of airport GSE. The process of electrification began in the 1980's with Eastern and United Airlines deploying the first electric equipment on the ramp. Some of the first pieces included aircraft tractors from Kersey, and baggage tractors from Charlatte. While Eastern and United deployed these units at other hubs, LAX was always in mind as the destination for large fleets of electrics.

In the early 1990's, American Airlines began a large program at LAX to replace all of their mobile GPU's and A/C units with bridge mounted electrical systems to reduce emissions and increase the reliability of those equipment types. In the late 90's United and American Airlines began to add electric baggage tractors and beltloaders to their fleet in limited capacities to replace their internal combustion units. Delta followed shortly afterwards. Continental, Skywest and FedEx began much later, but did so with the latest technology.

As each airline developed their electric programs, one thing became clear; electric vehicles were simpler more reliable and less costly to operate.

American

American's electrification project at LAX began in the mid nineties and carried on right up until September 11, 2001. American integrated their electrification program with their normal fleet replacement strategy at LAX. As internal combustion baggage tractors and beltloaders reached the end of their useful life and were retired, they were replaced with electric versions. This gave American the ability to grow their electric fleet slowly over time to help ramp employees adjust to the new equipment and resolve any challenges over time. Over the 6 year electrification period, American introduced nearly 60 electric baggage tractors and nearly 25 belt loaders plus 70 conventional chargers.

Figure 4-16
American Tractors and Chargers

During their electric program at LAX, American tested several new technologies to address the limitations of electric vehicles in a hub operation. One of the most unique technologies that were tested at LAX was a power sharing fast charging system. In a partnership with American, EPRI, INET, and AeroVironment worked together to introduce a product that could fast charge GSE while sharing 400 Hz power with the aircraft. This system would share centralized 400 Hz power with the aircraft at the gate. When the Aircraft required power, the charger would shut down and allow the aircraft to use the 400Hz, and once the aircraft was done, the charger would switch back on and charge the tugs that were plugged in. This project was developed because American had excess capacity on the 400 Hz system, but was short on house power at terminal 4. The test were so successful that American recommended the technology DFW Airport for the new terminal D.

Another vehicle technology that was tested at LAX was the Charlatte 350 electric cargo tractor. This tractor was a concept vehicle that introduced two new technologies, AC motors and all wheel drive. The Charlatte 350 was designed to increase the power of a normal baggage tractor to pull the heavier loads required by the cargo operation. While the unit was successful in the initial testing, it became a victim of the budget cuts of the post-911 down turn.

United

United had a similar program to American at LAX. United began their program in the mid 90's by replacing first their gas baggage tractors with electric followed closely by their beltloaders. In all United operates about 100 electric vehicles comprised of about 65 baggage tractors and 35 beltloaders.

Delta

Delta first introduced electric GSE into their operation in the late 1990's. Over the years they have grown their electric fleet at LAX to 13 electric tugs and 15 electric beltloaders. Delta's philosophy towards electric vehicles has always been financially driven, they understand the benefits of electrics, but they also take into account the higher initial cost of electrics and their limitations on the ramp. Delta is working to upgrade their charging infrastructure at LAX by changing all of their conventional chargers to fast chargers. They are also planning for future additions of electric vehicles when they make sense for the operation.

Continental

Continental began their electric program in 2001. After studying some of the successes and failures of the other airlines, Continental chose to approach their electric program as a partnership. They went out to the marketplace and invited vehicle manufacturers, battery manufacturers, and charger manufacturers to participate in a series of tests to see which technologies performed on the ramp better than others. The vehicle manufacturers included S&S Tug, Harlan, and Charlatte. Each vehicle was tested with similar batteries and the PosiCharge fast charger to determine which vehicle would perform to Continental's standards. In the end, the

MX4 baggage tractor and the 660E beltloader from S&S Tug were selected for performance and customer service.

Figure 4-17
Top: Delta Tractors and Chargers in Bag Room, Bottom: Continental Beltloader and Fast Charging System

Continental deployed their first electric vehicles and fast chargers at LAX in 2002. Continental's electric fleet includes four electric tugs, eight electric beltloaders and the first 10-port fast charger at LAX. Electric GSE has been very successful for Continental at LAX, and they will be adding additional electric vehicles as part of their normal fleet replacement program.

ASIG

ASIG Currently operates a fleet of about 20 electric tugs that they use to deliver connecting baggage between the different carriers and terminals at LAX.

FedEx

FedEx began their electrification program at LAX in 2004 when they introduced into their operation 14 electric belt loaders and 4 electric tugs. At that time, FedEx also installed 9 Dual-port fast chargers near their equipment staging area on the west side of the Airport. FedEx as the only package carrier operating Electric equipment at LAX has found success with the first pieces of electric equipment that they have deployed. They are currently looking into the feasibility of growing their electric fleet to possibly include Electric tugs for moving freight around the LAX Hub.

Figure 4-18
FedEx Beltloaders and Fast Charging Systems

US Airways

US Airways operates 10 electric bag tugs at Terminal 1.

Electrification Opportunities

Airlines

The major airlines, American, United, Delta, Continental, and Southwest present the largest opportunity to electrify the most ground support equipment and contribute to the largest reduction of emissions at LAX. The major Airlines represent the largest GSE fleets at LAX, and therefore present the best opportunity to reduce large amounts of emissions. The major carriers operate their own equipment at fixed terminal locations that are compact and well suited for electric vehicles. Additionally, they operate a diverse range of equipment, many of which can be electrified with very little negative impact to their operation. If the airport or the utility were to concentrate their efforts to assist the major airlines in their conversion to electric equipment they would receive the largest emissions reduction per dollar spent.

The most effective way to assist the major airlines in advancing their electrification programs would be to provide them with the charging infrastructure throughout the airport. If the infrastructure were provided for the airlines, it would increase the amount of money that the airlines would save by going electric which increases the Return on Investment (ROI). ROI is the principal measure that airline's financial analysts use to approve/deny capital expenditures. If the ROI for electrification is high enough, then the airlines would be able to purchase the electric vehicles faster and accelerate the conversion to electric.

In addition to providing the infrastructure, the airport or utility should work with GSE manufacturers through EPRI to further develop and deploy electric GSE that is in research today, similar to the model used by the military to speed the development and deployment of new technologies. The technology exists today to make an electric container loader, but the airlines do not have the time and resources to test and refine the technology to make a production version of the electric container loader. If the utility were to give incentives to the manufacturers and the airlines to accelerate that product from prototype to production ready, then the airlines would be able to change their internal combustion loaders to electric sooner.

Figure 4-19
FMC's Electric Container Loader

Ground Handlers

The major issue that prevents the Ground Handlers from going electric is the fact that they are migratory and short term providers. As contracted handlers, the very nature of their business is migratory. One day they are working with one carrier at terminal 3, and the next they are at terminal 6 working for another carrier. Additionally, their contracts are for relatively short time periods of time, so the ground handlers shy away from investment in infrastructure and costs that they can not pass on their customers.

To make electric GSE operationally feasible for the ground handlers, there needs to be infrastructure in place at all terminals. This infrastructure would have to be standardized so that all the systems were identical. That way, all the ground handlers could move electric equipment around the airport to support the changing nature of their business without having to relocate chargers every time.

To further assist the ground handlers in converting to electric, there needs to be a mandate from the airport that all ground handlers are required to electrify their fleets. Because the ground handlers work from short-term contracts, they can not pass on the cost of converting their fleet if their competition is not required to use electric; therefore, if the airport were to mandate the use of electric for all ground handlers they would all be on a level playing field. This would allow them to pass the costs on to their customers without the treat of losing the contract.

Package Carriers

The package carries are a little more difficult to electrify due to their location and operation. Most package carriers work from a central warehouse and the majority of their operation is conducted on open ramp space. They do not have terminal buildings close to the aircraft to house the infrastructure and reduce the amount of vehicle usage. This makes the electrification process a bit more challenging.

To electrify the Package Carriers' GSE fleet would involve a significant amount of cost and some operational changes. First the infrastructure would need to be brought out to the ramp or "plane side" This is difficult because most package carriers change the configuration of their ramp depending on the aircraft type and schedule that they are flying. Installing charging infrastructure plane side is much more expensive because it involves cutting the ramp and running power long distances out to where the planes part. It also involves building structures to house the electrical equipment and chargers. Once the infrastructure is in place, there is significantly less flexibility in changing the configuration of the ramp to accommodate schedule changes.

Electrifying the equipment for the package carriers is not impossible as FedEx has demonstrated over the past 3 years; it is just much more costly. Financial assistance with infrastructure and installation should increase the rate at which the package carriers adopt electric vehicles at LAX .

Infrastructure Requirements

The infrastructure requirements for electric GSE varies greatly depending on the vehicle types in service. For the current fleet of baggage tractors and belt loaders it can be assumed that a 10 to 15 kilowatt fast charger per vehicle is sufficient. The larger vehicles that are in development now will require 20 to 30 kilowatts per charger. If all the equipment at a wide-body gate were to be electrified it would require 12 charging ports with about 80 to 100 kilowatts in fast charging infrastructure. The following is a breakdown of that usage:

- Push tractor with 2 batteries – 20 to 30 kW
- Container loaders with 2 batteries each - 40 to 60 kW
- Belt loaders with 1 battery each – 20 kW
- baggage tractors with 1 battery each – 40 to 60 kW

If all the vehicles were plugged in at the same time, the gate would require a minimum of 120 to 170 kW. For a narrow-body gate, the requirement would be 6 chargers at about 40 kW.

Due to the development of fast charging, the requirement for the gate is only about 60% of the required infrastructure. Because fast charging is done intelligently, the system can optimize the charge for each piece of equipment based on its individual need. In this way the infrastructure can be shared and the net savings is about a 40% reduction in infrastructure requirements.

LAX Terminal Status

The current infrastructure at LAX can support this level of electrification. Below is a summary of the power available at each terminal.

- Terminal 1 — 4 – 3750 KVA Total Power Available
- Terminal 2 — 2 – 3750 KVA Total Power Available
- Terminal 3 — 2 – 1500 KVA Total Power Available
- Tom Bradley Terminal — 2 – 2000 KVA, 2 – 3750 KVA Total Power Available
- Terminal 4 — 2 – 3750 KVA Total Power Available
- Terminal 5 — 2 – 3750 KVA Total Power Available
- Terminal 6 — 2 – 3750 KVA Total Power Available
- Terminal 7 — 2 – 3750 KVA Total Power Available
- Terminal 8 — 2 – 2500 KVA Total Power Available

Alternate sources of power

Converting internal combustion GSE to electric will help reduce emissions sources at LAX, but if it drives additional power generation, it will not completely eliminate the green house gasses and other emission relating to the generation of electricity. To reach a true zero or near zero emission impact, renewable sources of power should be used to power the infrastructure for the electric GSE.

Solar

One of the best choices for renewable energy in Southern California is solar. Although Solar is not as efficient as other sources of power, it is the most reliable especially in Southern California.

FedEx has pioneered the use of solar power at airports by installing nearly 5,700 photovoltaic cells on the roof of the Oakland hub facility. The solar cells take up about 81,000 square feet of roof space, but they produce .9 Megawatts or 80% of the peak load requirement for the operation. With this kind of installation at LAX, the airport could charge 90 pieces of GSE with absolutely zero emissions. If the airport were to install this type of solar array on every terminal, the airport would have enough energy to charge over 800 electric vehicles.

Figure 4-20
Solar Installation at FedEx

The full article on the FedEx solar installation is available in Appendix A.

While solar is the most reliable form of alternative power, the cost is high and the cells only produce power during the daylight hours. There are other alternatives that are less expensive and provide power even after the sun sets

Wind

Wind turbines have been around for centuries. They have been used to power grinding wheels, and to pull water from arid deserts in rural environments for many years. In recent past, gigantic wind turbines have been mated to generators to produce massive amounts of power from a single unit. These units are not feasible for use in cities not only for their size and unsightliness, but also for safety reasons.

Figure 4-21
Examples of Wind Turbines

When most people think of wind power, they think of large farms with massive turbines that dominate the landscape. The wind farm of tomorrow is small and efficient and can be installed tastefully on most buildings so as not to distract from the architectural features of the building. While these modern generators are small, they are efficient and rely on several key technologies to gather more wind and generate more power than was once thought possible.

A string of small turbines strategically located on a building can produce enough energy to subsidize the energy usage of the structure. In windy conditions each unit can produce more than a kilowatt of clean energy offsetting the demand for costly peak power during business hours. During non-peak conditions, the turbines can power night lighting and even sell excess energy back to the grid.

Airports, Universities, and “Big Box” warehouse stores have installed these units to reduce their energy bills and in some cases assist them in LEED certification for green building practices.

Wave

Wave power is a new technology that is being used in costal regions to harness the renewable power of the ocean to generate electricity. Due to LAX’s proximity to the Pacific Ocean, wave power may be an alternative power source that can be harnessed at LAX with more reliability Than Solar and Wind.

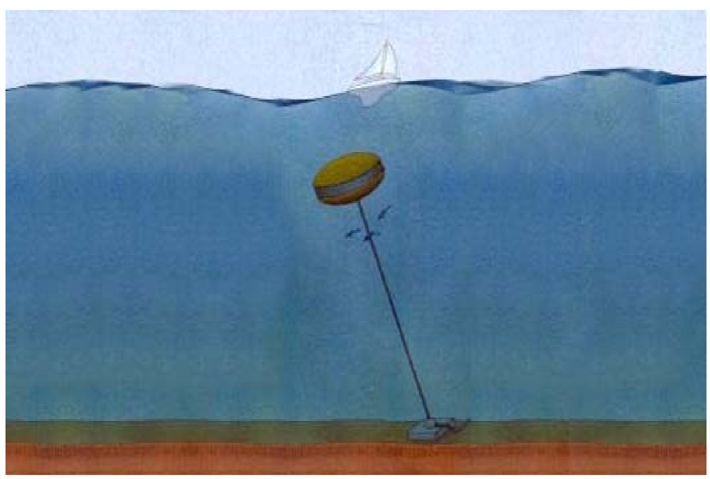

Figure 4-22
Wave Power

Wave power can be generated in several ways. The first is by installing turbines underwater to capture the energy in the waves as they approach the shore. Turbines attached to fixed mooring create traffic hazards to boats and could disrupt the flow of tidal sands and affect coral. If those same turbines were attached to a large float and anchored to the bottom of the ocean several feet below the surface. They could still generate power without the ill effects of a fixed turbine and be more effective in capturing tidal currents as well as wave action.

AeroVironment developed and tested this method of wave power generation, and is examining the effectiveness of a commercial variation of this technology.

A second method of harnessing the waves to generate renewable power is through the use of floating buoys. Electricity is generated by harnessing mechanical energy of the buoy rising and falling in the wave action. On December 18, 2007, Pacific Gas and Electric Company announced its support for plans to build the first commercial wave power plant off the coast of Northern California. The proposed plant consists of eight buoys, about 2 1/2 miles offshore, each buoy will generate about 250 kW as it rises and falls with the waves. The plant is scheduled to be online in 2012, generating a maximum of 2 megawatts.

Peak vs. Off Peak

Electric GSE is an ideal use of electrical energy at LAX. During “Peak” energy demand, most electric vehicles are actually out on the ramp performing their duties. While there is some charging that goes on during the peak hours, the majority of the energy that is consumed during the day is actually put into the batteries at night.

Baggage Tractors and Belt Loaders, the most common type of electric vehicles on the ramp today hold about a shift to a shift and half of energy in their batteries. They can be topped off during the day, but the majority of their energy will be pulled from the grid from the hours of 7:00 pm and 5:00 am. Vehicles that consume more energy like aircraft tractors and container loaders will need to be charged more often during peak hours, but will receive 40 to 50% of their energy during the hours of 10:00pm and 5:00am.

Power Sharing

In areas of LAX that are short on power, the charging systems can share power with other devices that are not used during the times that the chargers require power. Several demonstration projects have been conducted around the country to prove the concept of power sharing. Delta Air Lines at La Guardia and Atlanta, Southwest at Oakland, and American at JFK and LAX have all conducted power sharing studies. The device from which they share power is normally a Jetbridge, but power can be shared with Ground Power Units, HVAC systems, or any electrical devise.

5 RECOMMENDATIONS

Airport Infrastructure

Currently the largest roadblock to adoption is the differential upfront cost of the electric vehicle and infrastructure. Consider if you will the infrastructure required for internal combustion equipment. When an airport is constructed, provisions are made for the fuel farm to be built on site and pipes run to a fueling station. If the Airlines were required to build their own individual infrastructure to power their gas GSE, the cost would be prohibitive. By the same token, today the majority of the electrical infrastructure for operating electric vehicles has been borne by the carriers themselves. There have been no standards in the industry to consolidate the electrical infrastructure into one standard so that all the carriers can use the same facility as they do with fuel.

Some airports have seen this point of view, and have begun to provide infrastructure for the carriers. The best example of an airport providing the infrastructure for all the carriers is Burbank Airport. In 2004 Burbank installed charging systems at every gate and gave the airlines and ground handlers equal access to the infrastructure. As with fuel, the airport is billing the airlines for the cost of the energy, but used Passenger Facility Charges (PFC) to purchase and install the chargers. If Airports installed the infrastructure for the airlines, the positive economics of electric vehicles would drive the industry to utilize electric equipment. This penetration would occur at a much faster rate than other scenarios such as regulations on emissions control.

Utilities

Electric utilities have an opportunity to be in the forefront of serving their customers needs. The electricity loads needed are significant and utility involvement upfront is critical to ensuring consistent and reliable power can be served to the Airport.

An option for utilities to fully take advantage of this opportunity would be to work with EPRI to develop and test larger non-electric GSE as electric, to demonstrate the benefits of implementation even on the non-traditional platforms. Consider the energy that one aircraft tractor generates in one shift is equivalent to 4 to 5 baggage tractors operating for the same amount of time. The economic benefit to the Airport, Utility and ultimately the end-use customer, in addition to the emissions reductions, is very advantageous.

Another way that utilities can contribute to the GSE electrification process is to offer equipment leases to their airline customers. Some utilities discussed this option after 9/11 to assist the airlines in meeting their emissions commitments. If the utility owned the equipment and leased it to the airline, they might also be able to use the emission credit to off set other projects. If the utility did not want to carry the note on the lease, then they could at least buy down the lease rate from the financial institution. The real benefit of the lease is that the airlines realize the benefit of electric equipment without the higher upfront cost. If gas and Diesel continue to rise, a lease option would be cash positive for the airlines on day one. Meaning they would save more on the daily fuel cost than the difference between leasing gas and electric equipment.

Conclusion

The Airlines are facing some of the most difficult challenges today that they have ever faced. With Oil at $110 per barrel it takes a great opportunity to get the airlines to shift their focus from fuel and cost mitigation to strategic technology implementation. While electric vehicles have a great financial story to tell on their own, the up front cash outlay often causes projects to stall in the financial approval process. Any assistance from the Airports, Utilities, FAA or other regulatory agencies will tip the scale in favor of electrification and the benefits all stakeholders receive due to the improved efficiency of GSE.

A
SHARP AND FED EX CASE HISTORY

SHARP

solar electricity

SHARP SOLAR POWER SYSTEM INSTALLED ON FEDEX'S OAKLAND INTERNATIONAL AIRPORT

PROJECT

FedEx's Oakland International Airport hub employs 1,700 people and processes more than 260,000 packages daily. Along with labor and the price of fuel, electricity is one of the facility's major costs. It was no surprise when they announced plans to construct a 904-kilowatt (kW) solar electric system to reduce the effect of fluctuating energy prices. Working with Sharp, the project showed how corporate partnerships can help an organization like FedEx realize its environmental vision.

SOLUTION

FedEx flew more than 300,000 Sharp solar cells from Japan to Sharp's manufacturing facility in Memphis, Tennessee, where they were assembled into 5,769 photovoltaic modules. Berkeley-based PowerLight Corporation then designed and built the overall system using the Sharp solar modules. When completed, the 904-kW system covered 81,000 square feet of roof space and provided 80 percent of the facility's peak-demand electricity needs. "FedEx is proving that solar power works for business," said Oakland mayor Jerry Brown.

OVERVIEW

LOCATION:
Oakland, CA

INSTALLER:
PowerLight Corporation

DATE COMPLETED:
Summer 2005

PEAK CAPACITY:
904 KW

NUMBER OF MODULES:
5,769

PV SURFACE AREA:
81,000 square feet

SOLAR CELLS:
306,768

BECOME POWERFUL

> "With this project, FedEx will deliver more environmental innovation to California."
>
> – Mitch Jackson, managing director, Corporate and International Environmental Programs

The Oakland solar project is one of many environmental initiatives FedEx has undertaken. FedEx Express was the first company to make a long-term commitment to develop and use hybrid-electric delivery trucks. FedEx Kinko's initiatives include energy conservation, buying renewable power, using and promoting the sale of recycled products, and minimizing and recycling waste.

At peak output, the system will produce the equivalent of power used by more than 900 homes during the daytime. In addition to generating electricity, the solar modules help insulate the buildings, reducing heating and cooling costs. The 904-kW array is expected to cut the Oakland hub's electricity costs by 30 percent.

SYSTEM BENEFITS

- Over 30-year lifespan, system will replace 85,000 barrels of oil, 39 million pounds of coal, or 500 million cubic feet of natural gas.
- Reduction of carbon dioxide emissions by 10,800 tons, nitrogen oxide emissions by 17,000 pounds, and sulfur dioxide emissions by 15,000 pounds.
- Peak output production by system will be equivalent to power being used by more than 900 homes during the daytime.
- Oakland hub's electricity costs will be cut by 30%.
- System will provide 80% of the hub's peak-demand electricity needs.

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