ELECTRIC POWER
RESEARCH INSTITUTE

COMMERCIAL & INDUSTRIAL GUIDE TO ELECTRIC TRANSPORTATION

WHY ELECTRIC?

ELECTRIC TRANSPORTATION FOR BUSINESS

Commercial & Industrial Guide to Electric Transportation introduces the electric vehicles and equipment that are currently in use or being demonstrated, and the opportunities for further electrification in commercial and industrial applications.

Electricity currently moves materials, goods, and people over land and water, through airports and seaports, in mines, warehouses and manufacturing plants, and on city streets and private properties. It preserves perishables in transit, powers industrial sweepers, garden and agricultural equipment, and in some settings, trucks and heavy equipment.

Electric industrial vehicles and equipment are used off the road and out of sight of most consumers, who have only recently been exposed to the exciting new driving experience offered by plug-in electric vehicles. As consumer acceptance grows and market expansion drives down electrification costs, businesses that use commercial and industrial electric vehicles and equipment will also benefit.

Although the market for commercial and industrial electric vehicles and equipment has thrived for years, it is accelerating today, thanks to technology innovation and these market synergies.

This guide is organized by commercial and industrial market segment and type of equipment.

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BENEFITS OF ELECTRIFICATION

The demands of today's global economy drive business decisions that are based on cost, customer service, employee productivity, sustainability, and a host of other factors. Few available technologies can deliver measurable improvement in every metric. Electric technologies can.

Save Money. Electricity as a fuel for industrial and commercial vehicles delivers significant lifecycle savings. Higher capital costs—vehicle, infrastructure, and batteries—are quickly offset by lower fuel and maintenance costs. In short order, the payoff is tremendous.

Enhance Employee Safety, Health, and Satisfaction. Employees like the quiet, emission-free, vibration-free operation of electric vehicles. Sometimes it takes time for employees to get used to new electric equipment. Typically, once they accept it, they say they will not go back.

Support Efficient, Diverse, and Domestic Energy. Electricity is more efficient on an energy basis than gasoline, diesel, and most sources of propane. Electricity comes from home-grown, diverse sources, including renewable, fossil fuel, and nuclear resources.

Improve Productivity. Today's electric technologies can work through a full day, even multiple shifts in some applications. They can drive, lift, pull, and push as fast, as far, and as efficiently as their internal combustion counterparts. In many applications, electric industrial equipment performs better than the competition, improving operational efficiency.

Reduce Emissions. Electric industrial equipment produces zero smog-forming, particle, and greenhouse gas emissions in the workplace. Electricity is cleaner than gasoline, diesel, and propane, even when its generation emissions are counted.

Considering Electrification? Contact your local utility for answers to your infrastructure supply, load, reliability, power quality, and rate questions.

"The thing we at Carrier Transicold like about electricity is, it's available everywhere."

Dave Kiefer
Director of Sales, Marketing, Product Management
Carrier Transicold

"We ask all of our account managers who work with customers who transport people or have products being lifted, pushed or carried, to think about how it's being powered."

Cedric Daniels
Electric Transportation Program Manager
Alabama Power, a Southern Company

"Since Houston is designated a severe non-attainment area for ozone, we're focused on transportation electrification, on and off the road, to improve our region's air quality."

David Owen
Manager, Clean Air Technologies
CenterPoint Energy

DID YOU KNOW?

In any industrial setting, vehicles and equipment may sit unused for long periods between tasks. When internal combustion engines idle, they burn fuel, produce emissions, and are most inefficient. Electric equipment has an advantage because it does not idle. Moreover, an electric motor is roughly three times as efficient as an IC engine at converting energy to power at the wheels.

AIRPORT GROUND SUPPORT EQUIPMENT

Around the world, airports and airlines face pressure to meet increasingly stringent air quality standards and reduce costs. In response, many are replacing internal combustion ground support equipment with electric GSE that offers comparable functionality, reduces emissions, and lowers operating costs. Conversion brings immediate benefits. IC equipment typically idles for 20–50% of a daily shift, while electric GSE does not idle. Retrofit kits and new electric equipment are available.

TOW TRACTORS

Application: Tow tractors move equipment that cannot move itself, such as carts loaded with passenger baggage or cargo, mobile air conditioning units, air starters, and lavatory carts.
Technology: Most operate at 72–80 VAC, with a 30 kW AC motor and 500–625 Ah lead-acid battery. Like their IC counterparts, drawbar pull capacity for electric tractors ranges from 3,500–5,000 lbs.
Typical Input Demand: 10–20 kW
Typical Annual Energy Usage: 32,120 kWh

BELT LOADERS

Application: Belt loaders are self-propelled mobile conveyors used to load baggage and cargo into an aircraft cargo hold.
Technology: Both AC and DC systems, operating at 48–80 V, are common. Electric belt loaders can service a range of aircraft sizes from small regional jets to large wide-body jets. Typical weight capacity is 2,000 lbs.
Typical Input Demand: 5–10 kW
Typical Annual Energy Usage: 4,941 kWh

CONTAINER LOADERS

Application: Container loaders are self-propelled mobile vertical platform lifts used to load large containers and cargo into aircraft.
Technology: An electric loader typically operates at 160 VAC and is able to lift 15,500 lbs. IC loaders typically handle larger, heavier loads.
Typical Input Demand: 20–40 kW
Typical Annual Energy Usage: 29,200 kWh

PUSHBACK TRACTORS

Application: Pushback tractors push aircraft backwards, away from the airport gate. Electric pushbacks are capable of moving small to mid-sized aircraft ranging from regional jets to 737s and 757s.
Technology: Electric pushbacks typically operate at 40–80 VAC or VDC, with one or two 26–45 kW motors, and one or two 500–930 Ah batteries. Some use a towbar, others use a cradle. Drawbar capacity is up to 28,000 lbs. Lift cradle capacity is up to 200,000 lbs.
Typical Input Demand: 10–20 kW
Typical Annual Energy Usage: 21,900 kWh

DID YOU KNOW?

Electric service and lavatory trucks, maintenance and service lifts, and stairs are also commercially available for airside or ramp operations. Lithium batteries are being tested in GSE today and may enable electrification of vehicles with higher duty cycles in coming years. Landside electrification opportunities include people movers inside the terminal, parking shuttle buses, utility vehicles and managers' trucks, and public charging infrastructure for passengers and employees who drive plug-in electric cars.

GROUND POWER UNITS

Application: Ground power units provide electricity for parked aircraft. An electric GPU replaces either a portable diesel generator or the aircraft's auxiliary power unit, which burns jet fuel at a rate of 28 gallons per hour.

Technology: Electric GPUs can be wired directly into AC power at the gate. Common operating profiles are 380–480 VAC, three-phase, 45–180 kVA. Unlike standard U.S. electrical grid power at 60 Hz, aircraft require electricity at 400 Hz, so GPUs convert power to meet aircraft needs.

Typical Input Demand: 40 kW

Typical Annual Energy Usage: 262,800 kWh

PRECONDITIONED AIR UNITS

Application: Preconditioned air units blow fresh air into the aircraft while it is parked at the gate. Historically powered by diesel generators, "PC air" units can instead be powered by electricity and wired directly into AC power at the gate.

Technology: Air-conditioning capacity is 30-, 60-, and 100-tons, with 30-ton units common for mid-size jets. They typically operate at 208–480 VAC.

Typical Input Demand: 105 kW

Typical Annual Energy Usage: 693,113 kWh

CHARGING AND INFRASTRUCTURE CONSIDERATIONS

Conventional and fast charging strategies for ground support vehicles are both common. Conventional chargers may be more cost effective and successful in certain applications. Fast charging is increasingly popular despite higher upfront costs because it saves space by enabling a variety of vehicles to use the same charger. A single 10 kW conventional charger per vehicle or a 10–80 kW fast charger with multiple ports to serve multiple vehicles is considered sufficient.

In general, tapping into electricity at the gate is easier than cutting concrete. Although power availability can depend on many factors including the age of the terminal building, power requirements are often less than expected, so power availability may be a perceived, not real, limitation.

"It's a tremendous savings. We're saving at least $50–$60 million a year in fuel burn alone by switching from diesel APUs to electricity."

Rick Waugh
Senior Manager, GSE Western Region
Southwest Airlines

"Give me electric. I'll take electric any day. It makes a difference when you're trying to communicate. The less noise you can have out here is the best way."

Artis Johnson
Ramp Agent
Southwest Airlines

"They have good torque and they pull four full carts of bags with ease. They're great. They stop well, they handle well, they turn on a dime."

Eric Colacioppo
Ramp Agent
Southwest Airlines

DID YOU KNOW?

Most major airports have already installed 400 Hz power to support aircraft ground power and PC air needs. Smaller regional airports are beginning to do the same in anticipation of their airline tenants' increased electrification needs.

Passenger loading bridges at most airports already have dedicated electrical infrastructure. Because they operate intermittently—an average of 5 minutes per hour—their electrical infrastructure can also support charging stations for electric GSE.

SEAPORTS AND INTERMODAL TRANSFER CENTERS

In seaports and intermodal transfer centers around the world, heavy equipment, historically powered only by diesel, can now be powered by electricity—either by being retrofit or as new equipment. Electricity offers a superior environmental choice and utilizes the newest technology that enables faster and more efficient goods movement, resulting in a swift return on investment.

CRANES

Application: Ship-to-shore and gantry cranes are common in ports and intermodal centers. Some models of each crane type can be powered by electricity.

- A ship-to-shore (STS) or quay crane is a rail-mounted dockside crane that transfers containers to and from ships at port.
- A gantry crane straddles stacks of shipping containers. It moves containers and consolidates stacks as containers are loaded onto trucks or railcars. A rubber-tired gantry (RTG) crane typically runs on 8–16 wheels, directly on the pavement surface. A rail-mounted gantry (RMG) crane runs on two rails.
- A wide-span RMG crane can span a width of 14 containers (150 ft.), thus providing access to multiple lanes of railway tracks, truck lanes, and container stacking areas. Because of their size, wide-span cranes are typically used in new or redesigned intermodal centers. They can increase throughput by up to 30%.

Technology: Electricity is supplied from the grid. Electric cranes typically are powered by an elevated busbar or a cable reel, which is mounted to the crane or stored in a trolley cart that follows the crane; the feed cable can be as long as 4,000 feet. Electric STS and RTG cranes operate at 4,160–13,800 VAC. One wide-span crane manufacturer specifies three-phase, 50/60 Hz, 10–15 kV. Power demand and energy use vary widely depending on hours of operation, number of lifts, container weight, weather, time of day, and use of regenerative braking.

Typical Input Demand: 136 kW for STS; 330–420 kW for RTG; 540 kW for wide-span RMG

Typical Energy Usage per Lift Cycle: 3.4–4.5 kWh for STS; 2.2–4.6 kWh for RTG; 2.2–3.4 kWh for wide-span RMG

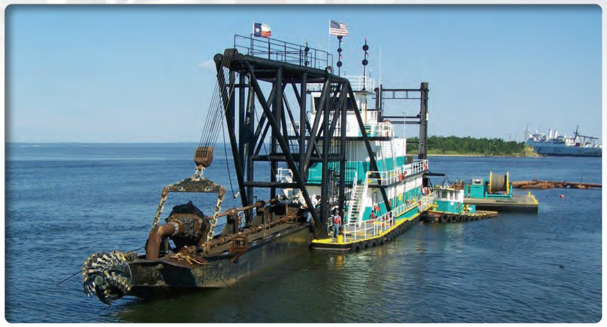
INFRASTRUCTURE CONSIDERATIONS

Electrical infrastructure needs vary, and can include the high voltage source and switchgear, electrical power from the substation to the crane switchgear, cabling from the switchgear infrastructure to the crane vaults, busbars, and in-the-ground or overhead lines. Electric wide-span cranes require power at several points, including the main hoist, the gantry, and the trolley drive.

DID YOU KNOW?

The power draw of an electric RTG analyzed at one port ranged from a maximum of 356 kW when lifting a container to -3.29 kW, demonstrating regenerative energy when lowering a container.

Due to the nature of seaport and intermodal yard operations, where goods are lifted, moved, and stacked, equipment may run continuously for hours or be inactive for 30–40% of a shift.



DREDGES

Application: A dredge uses scooping or suction devices to deepen harbors and waterways, restore beaches or wetlands, and dig in other underwater applications. An electric dredge uses shore power delivered via a large cable, and can be beneficial for long-term projects.

Technology: Operating profiles, power demand, and energy use vary widely depending on the size and type of dredge, material being dredged, and hours of use. One estimate indicates 480 VAC, 80 amps.

Typical Input Demand: 2.4–4.8 MW

Typical Daily Energy Usage: 36,510–115,000 kWh

HARBOR CRAFT

Application: Electric options for harbor craft are new to the market. A commercially available battery-powered pleasure boat could replace a traditional IC boat for use at an industrial plant on a lake or self-contained waterway. A hybrid tugboat and electric ferries are in use and being demonstrated.

Technology: Small craft systems range from 2.5 kW for boats under 25′ to 39.8 kW for boats up to 85′. An electric passenger ferry demonstration in Sweden uses two 125 kW motors; its batteries are fast-charged using a 600 kW charger. An electric car ferry demonstration in Norway will use two 450 kW motors. A hybrid ferry demonstration in San Francisco combines a 320 kW electric motor and 380 V battery pack with wind turbines, a solar array, and marine diesel engines.

Typical Input Demand: 3–35 kW for small craft; 80–600 kW for large craft

Typical Energy Usage per Charge: 15–175 kWh for small craft, 5 hrs.; 108 kWh for large craft, 20 mins.

"The hourly operating cost of GPA Savannah's electric RTGs is about 85% less than diesel, with payback calculated in 3.75 to 5 years."

Richard Cox
Moffatt & Nichol, former General Manager of Equipment and Facilities
Georgia Ports Authority, Savannah

"With our all-electric ship-to-shore cranes, GPA has avoided using 2 million gallons of diesel annually since 2001."

Christopher B. Novack
Director of Engineering and Facilities Maintenance
Georgia Ports Authority, Savannah

DID YOU KNOW?

Refrigerated cargo containers can be plugged in or stacked in electric-powered "reefer" racks while awaiting ground transfer. A ship can be retrofit to shut down its engines and plug into shore power while at dock. Other electric options for seaports include forklifts and automated guided vehicles. Short-distance electric yard hostlers at ports and distribution centers are also being demonstrated.

MINING

Electricity currently powers a significant share of the heavy equipment used in underground and surface mining. Continuous miner and longwall systems that remove coal and other minerals, roof bolters that secure the overhead rock underground, and most draglines are line-powered. Other pieces of moveable equipment that still rely on diesel can also be line-powered or tethered, or use batteries. Opportunities for further electrification abound, especially underground.

SHUTTLE CARS, RAM CARS, AND SCOOPS

Application: Shuttle cars, ram cars, and scoops move heavy loads—10 to 20 tons—of mined materials short distances underground. Vehicles may be electric-powered by reel-mounted cable or battery, or diesel-fueled.

Technology: The operating voltage of battery ram cars and scoops is typically 128 VDC. New-generation 4-wheel drive vehicles, one with two 50–85 kW variable frequency drive AC traction motors and 240 V battery, promise greater torque, speed, regenerative braking, reduced maintenance, and twice the battery life of conventional DC-powered equipment.

Typical Input Demand: 130–230 kW

Typical Daily Energy Usage: 864–1,138 kWh

PEOPLE MOVERS

Application: Some mines use a dedicated vehicle called a mantrip to transport up to 18 people to, from, and within the mine. Other mines use high-ground-clearance pickup trucks and Humvee-like transporters. Vehicles must be able to traverse rough, muddy, sometimes slick terrain, and a grade as steep as 18%.

Technology: Mantrips can be diesel- or battery-powered. Battery-powered vehicles typically operate at a range of 48 VDC for 2- to 4-person carriers to 128 VDC for 14- to 16-person carriers.

Typical Input Demand: 39 kW

Typical Daily Energy Usage: 366 kWh

MINING LOCOMOTIVES

Application: Some underground mines with rail systems use mining locomotives to haul people, equipment, and materials inside the mine. Electric locomotives can replace diesel locomotives in many applications.

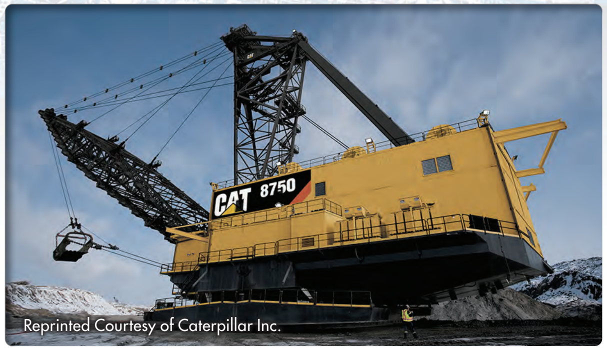
Technology: Electricity is delivered by trolley lines at 300 or 600 VDC or by batteries that operate at 120 VDC, or in combination. Typical electric locomotives are powered by one or two electric motors. Battery size ranges from 660 Ah for locomotives that move people to 1,750 Ah for those that move materials.

Typical Input Demand: 90–170 kW

Typical Daily Energy Usage: 306–1,080 kWh

DID YOU KNOW?

Electric equipment enhances worker safety in underground mines. Its zero-emissions operation improves air quality. It runs quietly, aiding workers' ability to hear and speak—a necessity in the darkness where visual cues may be impossible. Industrial fans, also powered by electricity, circulate air and remove noxious or poisonous gases from underground mines.



Reprinted Courtesy of Caterpillar Inc.

CONVEYORS

Application: Conveyors in both underground and surface mines transport bulk material from the mine to a staging point or processing plant. When conveyers replace heavy-duty diesel trucks, the operational, maintenance, and fuel savings add up quickly.

Technology: Conveyors use a series of belts and rollers propelled by line-powered electricity to transport materials. Power demand and energy use for this custom-made equipment varies widely depending on length, terrain, and materials weight. Examples below are to convey coal distances of 2,000–5,280 ft. with elevation gains of 50–100 ft.

Typical Input Demand: 150–340 kW

Typical Daily Energy Usage: 2,400–5,440 kWh

DRAGLINES AND SHOVELS

Application: Draglines and mining shovels are massive digging machines. Draglines can collect 75–150 cu. yd. of material at once. Shovels have 10–100 cu. yd. dipper capacity. Most draglines are all-electric; some connect to the grid, others to diesel generators. Shovels can be diesel- or electric-powered.

Technology: One dragline uses six to ten AC motors at 932–1,230 kW each for the hoist, drag, and swing operations, and four walking motors at 932 kW each. One electric rope shovel manufacturer specifies an operating system of 50/60 Hz, 7,200 V. Power demand and energy use for this custom-made equipment varies widely.

Typical Input Demand: 7–14 MW for dragline;
900 kW–2.4 MW for rope shovel

Typical Daily Energy Usage: 75,153 kWh for dragline;
43,956 kWh for rope shovel

"Electric technologies can contribute to increased efficiency and safety, and reduced operating costs for today's mining operations."

Toby Steele
Founder
APEX Chargers, LLC

DID YOU KNOW?

Some makers of huge trucks with 200–360-ton hauling capacity used in surface mines have incorporated hybrid-electric drive technologies to aid traction control on steep grades. Some trucks can connect to overhead power lines via catenaries, enabling all-electric drive operation for portions of the haul route.

Reprinted Courtesy of Caterpillar Inc.

MOVING GOODS

In warehouses and industrial parks, on the nation's highways, and on city streets, electricity is powering the equipment that directly moves or supports the transfer of consumer and bulk goods.

FORKLIFTS

Application: Forklifts, also called lift trucks, are classified by size and fuel. Classes 1 through 3 are electric. Classes 4 and 5 are internal combustion. Electric forklifts primarily use lead-acid batteries, although lithium batteries and hydrogen fuel cells are in demonstration. IC forklifts are usually fueled by propane, but also use natural gas, gasoline, and diesel.

Class 1 electric forklifts can do the work of most Class 4 IC forklifts and are similar in use. Both are counterbalance trucks. When fitted with solid tires both are used indoors.

Class 1 electric trucks can replace Class 5 IC trucks often used outdoors. Outdoor forklifts, whether Class 1 electric or Class 5 IC, have pneumatic tires to improve handling on rough surfaces. They also have enclosed motors and electronic systems to ensure safe operation in wet, dusty, windy conditions, and sometimes have an enclosed cab for the driver.

Technology advancements such as higher voltage and AC-drive systems, and high-frequency charging have boosted electric forklift performance and utility, and therefore industry acceptance. Even in the most demanding operations, a lift truck is typically in use only 50% of the time, so most modern electric lift trucks can operate for two 8-hour shifts on a single battery and charger, five days a week. Unlike IC forklifts, when electric forklifts are not in use they are not idling and burning fuel.

Technology: Most Class 1 electric indoor or outdoor forklifts operate at 36 V, 48 V, or 80 V. Most new trucks use AC drive motors. Typical lift capacity is 3,000–12,000 lbs. Models with up to 20,000 lbs. capacity are available.

A Class 2 indoor narrow-aisle forklift typically has 3,000–5,500 lbs. lift capacity, reaches heights of up to 42 ft., and operates at 24 V, 36 V, or 48 V.

Typical Input Demand: 7.6–30 kW

Typical Annual Energy Usage: 12,960–25,932 kWh

CHARGING AND INFRASTRUCTURE CONSIDERATIONS

Today's new charger technologies can charge multiple batteries at once, in the forklift, eliminating the need for extra batteries and a battery room. They also are more energy-efficient and can save space. Most industrial facilities currently operate on the 480 VAC three-phase electricity needed to accommodate these charging regimes. Facilities operating on 208 VAC have other conversion options.

DID YOU KNOW?

Building new floor space is expensive and time-consuming. Instead of adding square footage, growing operations may opt to reconfigure existing space to a compact, vertical orientation. Converting a forklift fleet from IC Class 4 to electric Class 2 can save time and money, and improve operational efficiency since some Class 2 trucks can operate in aisles as narrow as 6 ft. Electric automated guided vehicles, or AGVs, may also offer efficiency and space solutions, and are growing in popularity.

TRUCK STOP ELECTRIFICATION

Application: While parked, long-haul truck drivers can plug into the grid instead of idling their truck or auxiliary engines to power their truck's heating, air conditioning, and accessories. Truck stop electrification sites exist in almost every state.
Technology: In a truck equipped with onboard electrification capability, a driver plugs into a fixture in the parking space that delivers 120 VAC and 208 VAC power. An alternative is off-board systems, where the heating, air conditioning, and electrical infrastructure are installed on overhead gantries or large pedestals to supply each parking space.
Typical Input Demand: 1.5 kW
Typical Annual Energy Usage: 3,750 kWh

TRANSPORT REFRIGERATION UNITS

Application: Transport refrigeration units, TRUs or "reefers," control the temperature of cargo on trailers, trucks, and containers. Traditionally powered by an onboard diesel engine or generator, TRUs with electric standby can now plug into shore power at home base or during stops. One all-electric TRU is designed for stationary or portable cold-storage applications.
Technology: TRUs for different truck and cargo configurations operate at 115 V, 230 V, or 460 V.
Typical Input Demand: 8–9 kW for trailer TRUs
Typical Annual Energy Usage: 15,000 kWh

INFRASTRUCTURE CONSIDERATIONS

A single pedestal to supply 208/120 VAC three-phase power to an onboard truck stop electrification system and 480/277 VAC three-phase with a step down for a TRU will require 100 amp service. A truck stop may install 6–12 pedestals per location. An off-board truck stop electrification system requires more extensive infrastructure. A big intermodal warehouse may have several hundred docking bays for TRUs.

"We recently helped a customer convert to electric forklifts. Using the EPRI lift truck calculator, we estimated that the customer would save about $54,000 per truck in fuel and maintenance costs over five years."

Marshall Cromer
President
Cromer Material Handing

"The ROI is fairly quick. Even if a truck driver spends $2,000 to upgrade their system, payback is going to be within 6 months."

Alan Bates
Vice President of Marketing
Shorepower Technologies

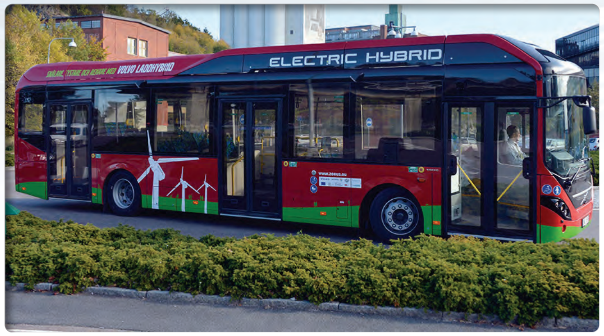
DID YOU KNOW?

As of 2014, idle reduction laws are in force in 38 states or jurisdictions. A Class 8 long-haul truck burns roughly 1–1.5 gallons per hour when idling. A diesel TRU burns up to 1 gallon per hour.

The New England Produce Center in Chelsea, Mass., replaced 98 diesel TRUs with all-electric models, reducing emissions by 1,025 tons and fuel consumption by 268,000 gallons, and saving $590,000 in operating expenses each year.

MOVING PEOPLE

At least 24 light-duty plug-in electric vehicle models are or will soon be available in the U.S. market. Electric transit buses are on the road demonstrating commercialization potential, and electric intercity, passenger, commuter, and light rail have long been used to efficiently move people in urban and suburban areas.



LIGHT-DUTY OPTIONS FOR FLEETS

Application: Most PEVs are being marketed to consumers; some are well-suited for fleets.

Technology: A plug-in hybrid is powered by an internal combustion engine and one or more electric motors; PHEV battery capacity ranges from 4.4–17.1 kWh. A battery electric vehicle is powered by an electric motor and battery alone; BEV battery capacity ranges from 16–85 kWh.

Typical Input Demand: 3.3–20 kW

Typical Electricity Usage per Mile: 0.405 kWh for PHEV; 0.257 kWh for BEV

PUBLIC TRANSIT

Application: Domestic and international manufacturers are producing 40–60 foot electric transit buses for demonstration and commercial service worldwide.

Technology: Battery capacity for battery electric buses ranges from 38–360 kWh. Buses with smaller batteries are typically paired with fast charging or on-route charging using automated docking systems that deliver a charge in minutes. Those with larger batteries employ more traditional charging strategies, such as 8 hours at 48 kW, 4 hours at 80 kW, or 1.2 hours at 200 kW. One model uses super-capacitors charged by a catenary.
A plug-in hybrid model has a 4.8 kWh battery for short-distance electric operation in inner cities.

Typical Input Demand: 100–400 kW

Typical Electricity Usage per Mile: 1.45 kWh for plug-in hybrid; 1.81–1.92 kWh for battery electric.

Photo courtesy Amtrak®

DID YOU KNOW?

Light rail and trolley systems used in cities across the United States rely on grid power supplied through a third rail or a catenary. Catenaries supply electricity to power much of the commuter and intercity rail service in the Northeast. The newest Amtrak® Cities Sprinter or ACS-64 electric locomotive entered service in February 2014 to serve the Washington to Boston corridor. Power output is 6,400 kW. Power supply varies along the route from 25 kV/60 Hz to 12.5 kV/60 Hz and 12 kV/25 Hz.

WORK TRUCKS FOR FLEETS

Delivery, utility, and municipal fleet managers are successfully demonstrating—and adding—medium- and heavy-duty plug-in hybrid work trucks and vans to their fleets. Electric utilities, in particular, have an opportunity to lead the plug-in revolution by example.

UTILITY WORK TRUCKS

Application: Plug-in hybrid line, trouble, bucket, crane, and other utility work trucks are available today. Specialty truck makers integrate electronic components with different manufacturers' chassis and engines. Since a typical utility bucket truck idles 3–4 hours a day, the emissions reductions and fuel savings are significant. Some configurations also operate in hybrid-drive mode, providing even more savings.

Technology: Exportable power ranges from 3–18 kW. Hybrid drive system electric motor is 58–80 kW. Battery capacity ranges from 14.2–28.4 kWh.

Typical Input Demand: 3.3–6.6 kW

Typical Daily Electricity Usage: 25 kWh

DELIVERY VEHICLES

Application: Delivery vehicles are prime electrification candidates. They typically travel fixed daily routes under 80 miles, stop and start often, and return to a single location to refuel.

Technology: Options range from plug-in hybrid to all-electric drivetrains in pickups, vans, step vans, and other models. One plug-in hybrid powertrain designed to work in light trucks, SUVs, and delivery vans uses a 23 kWh battery, a 190 kW peak electric motor, and provides exportable power of 14.4 kW at 50 amps.

Typical Input Demand: 3.3–14.5 kW

Typical Daily Electricity Usage: 20–50 kWh

"We have several plug-in electric work trucks in our fleet, including 55-foot material-handling bucket trucks, step vans to perform underground utility repairs, and mobile fuel tankers to refuel equipment at our nuclear sites. In each application, energy from the grid provides hydraulic power to the equipment and tools, cab heating and air-conditioning for the operators, and exportable power for lighting, tools, and other purposes. We expect to see a substantial reduction in fuel costs, while providing a quieter and cleaner operating environment for our employees, customers, and the broader community."

Mike Allison
Director, Fleet Design and Technical Services
Duke Energy

DID YOU KNOW?

Demonstrations of heavy-duty trucks using pantographs connected to a catenary line in congested urban areas and electric switcher locomotives at rail yards present possibilities for electrifying even the heaviest of vehicles. Wireless in-road electric vehicle charging is in development.

Photo courtesy:
www.siemens.com/press

OTHER ELECTRIC OPTIONS

From vehicles that move people and goods to equipment that cleans and maintains facilities and grounds, there are countless other electric options.

UTILITY VEHICLES

Utility vehicles, also called burden or personnel carriers, transport people and goods indoors in large industrial buildings, and outdoors on private campuses off city streets. Some utility vehicles are designed for rugged all-terrain, off-road use such as on farms or military bases, and have all-wheel drive and a 1,500-lb. towing capacity.

LOW-SPEED AND NEIGHBORHOOD ELECTRIC VEHICLES

Low-speed vehicles are a class of 4-wheeled vehicles that can attain speeds of up to 25 mph and, when outfitted with designated safety equipment, are legal to drive on city streets of 35 mph or lower. Neighborhood electric vehicles are a type of LSV, as are some utility vehicles.

LAWN AND GARDEN EQUIPMENT

Turf trucks, agricultural sprayers, pressure washers, blowers, and lawnmowers are a few examples of the range of lawn and garden equipment that is available in electric-powered models to replace IC models.

SWEEPERS, SCRUBBERS, AND RESURFACERS

Sweepers, scrubbers, and resurfacers clean almost any outdoor or indoor surface imaginable. From parking lot pavement to grocery store floors, and from tennis courts to skating rinks, many electric models of this class of cleaning machine are available and used around the world to replace IC models.

DID YOU KNOW?

Electric-powered bicycles, golf cars, and individual transporters are available in the consumer market and have uses in a wide range of commercial and industrial applications ranging from manufacturing plants to law enforcement.

CHARGING PRIMER

The strategies for powering industrial electric equipment are as diverse as the equipment itself, ranging from 120 VAC power cords to high-voltage, high-current direct feeds and catenaries. A majority of electric equipment relies on chargers, of which there are many sizes and designs, to supply current to the equally varied types of batteries. Battery charging technologies have advanced dramatically.

INDUSTRIAL HIGH-FREQUENCY CHARGING

Traditionally, operations using electric industrial vehicles have had a dedicated battery room, with two or three batteries and a ferroresonant or SCR charger for each vehicle. Each charger matched the specific lead-acid battery size, equipment type, and workplace application, and was about 70–80% efficient.

New high-frequency chargers are smaller, lighter, save floor space, are more than 90% efficient, and can use a building's single-phase or three-phase AC electricity. Power ratings of 3.5 kW, 6 kW, 10 kW and 21 kW are common. Batteries typically carry a five-year warranty.

INDUSTRIAL FAST CHARGING

Fast charging is increasingly popular. It reduces the vehicle's time on the charger, thereby increasing its time working. Fast charging allows a battery to regain some energy during breaks and shift changes and is a space- and time-saving strategy for multi-shift operations or busy airports. One manufacturer's 16-port unit for airport GSE has an 80 kW power rating. Battery warranties may be reduced to three years when fast charging is employed.

LIGHT-DUTY VEHICLE CHARGING

The lithium batteries in today's light-duty plug-in electric vehicles can charge from a 120 VAC outlet, however most drivers are opting to install 3.3 or 6.6 kW charging stations that operate at 208/240 VAC. Commercial fast charging stations delivering 44 kW–120 kW at 480 VDC are being installed in strategic locations across the country to accommodate models equipped to accept fast charging.

"As material handling operations migrate to electric lift trucks, they can run multiple shifts on a single battery, eliminate battery rooms, and save money using today's high-frequency chargers. In the future, many may choose fast charging. A Navigant Research study found that fast charging is expected to increase by 300% between 2013 and 2020."

Mark Tomaszewski
Regional Manager, Emerging Technologies
EnerSys

"More than 90% of the chargers sold to the GSE market are fast chargers, and that trend is increasing with the larger GSE vehicles being converted to electric."

Ryan Gibson
Sales Director
AeroVironment PosiCharge

DID YOU KNOW?

Multi-unit chargers enable multiple vehicles to charge simultaneously. They are available using both high-frequency and fast-charging technology.

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