REPORT OF THE COMPTROLLER GENERAL OF THE UNITED STATES

Potential For Using Electric Vehicles On Federal Installations

Many high-performance conventional vehicles are being used by Federal agencies for tasks which could be handled by lower performance vehicles that offer advantages of reduced costs, energy consumption, and air pollution.

This report compares the performance, cost, energy use, and environmental pollution characteristics of electric vehicles with conventional vehicles.

LCD-76-206

MARCH 3, 1976

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-135945

The Honorable Gilbert Gude
House of Representatives

Dear Mr. Gude:

As you requested, we have reviewed the potential for using electric vehicles on Federal installations. Our work was divided into two phases. Phase I explored and studied the characteristics of electric vehicles and compared the performance, economics of operation, use of energy, and environmental pollution characteristics with conventional vehicles. Phase II assessed the potential of using these vehicles on Federal installations by visiting selected installations to examine facility traffic characteristics and use patterns. We limited our review to battery-powered vehicles as opposed to electric trains or buses energized through rails or overhead lines.

Only limited information on electric vehicle operational and maintenance costs is available. Consequently conclusions on replacing conventional vehicles with electric ones would not necessarily apply to all situations. However, we believe that many conventional, high-performance vehicles restricted to on-the-facility use could be replaced by electric vehicles or low-performance, gasoline-powered vehicles. Low-speed electric vehicles are economically attractive but many relatively high speed electrics* are not. Replacing conventional vehicles with low-performance vehicles of either electric or conventional design would result in lower energy consumption and lower air pollution levels.

Our work is summarized below. Additional detail has been provided in the appendix.

--Electric vehicles can be grouped into two broad classes consisting of off-the-road and on-the-road type vehicles. Although electrics have been in use since the early 1900s, few on-the-road vehicles are currently in fleet service. However, there are more than 400,000 off-the-road electrics in service and their market is considered established. (See p. 1.)

--Electric vehicles are special purpose vehicles. Low-performance characteristics, such as short ranges, low acceleration and poor hill climbing ability, and often low, top speeds restrict their usefulness. (See pp. 4 to 6.)

--Electric vehicles do not produce exhaust gas emissions but they do contribute to air pollution when they use electricity generated in power plants fueled by coal or oil. In 1974, about 62 percent of electricity produced in the United States was generated from coal and oil fuel sources. Power plant stack gas emissions, like sulfur dioxide and oxides of nitrogen, can seriously aggravate the air pollution problem. (See pp. 6 to 9.)

--Electric vehicles use less petroleum. Much of the electricity used to recharge batteries of electric cars would come from generating plants using coal, nuclear energy, and hydropower. (See pp. 9 and 10.)

--Electric vehicles are not necessarily energy conserving. They will conserve energy as they replace high-powered conventional vehicles, particularly on routes characterized by low-speed, multistop driving. However, electrics are unlikely to conserve energy when replacing conventional cars with similar weight-to-power ratios such as subcompact cars. (See pp. 9 and 10.)

--Compared with conventional vehicles, electrics may or may not be economically attractive. Off-the-road electrics are likely to be economically attractive because their acquisition cost is often comparable to, or moderately higher than, the conventional vehicles they replace. On-the-road electric vehicles may be unattractive because acquisition costs often are between two to three times higher than those of comparable conventional vehicles. In such cases, the lower electric vehicle operation and maintenance costs are unlikely to offset acquisition cost during the lifetime of the vehicle. (See pp. 10 to 12.)

--Many vehicles on Federal installations are overpowered for the tasks they are assigned to do and could be replaced by electric vehicles or low-performance, gasoline-powered vehicles. (See pp. 12 to 15.)

As agreed with your staff we plan to send copies of this report to selected congressional committees and executive agencies 5 days after sending it to you.

Sincerely yours,

Elmer B. Staats

Comptroller General
of the United States

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BACKGROUND

Electric vehicles were in common use during the early 1900s but shortly thereafter on-the-road use was largely abandoned. Today few are being used on public roads. An attempt to market on-the-road electric trucks was made in the 1950s and again in the mid-1960s when interest for electric cars resurged. Both attempts failed due to lack of demand. Interest was revived in the late 1960s because electrics were seen as one possible solution to the Nation's air pollution problem and recent interest was stimulated because of the gasoline shortage. However, high acquisition cost and performance limitations still restrict the demand for on-the-road electric vehicles.

Off-the-road use, on the other hand, has been established. For example, more than 197,000 electric golf cart are being used, representing about 75 percent of the golf cart market. Similarly, more than 200,000 electric material handling forklift trucks and more than 20,000 electric in-plant vehicles are being used nationally. Off-the-road use has been popular because the vehicles serve special needs and they are often economically attractive.

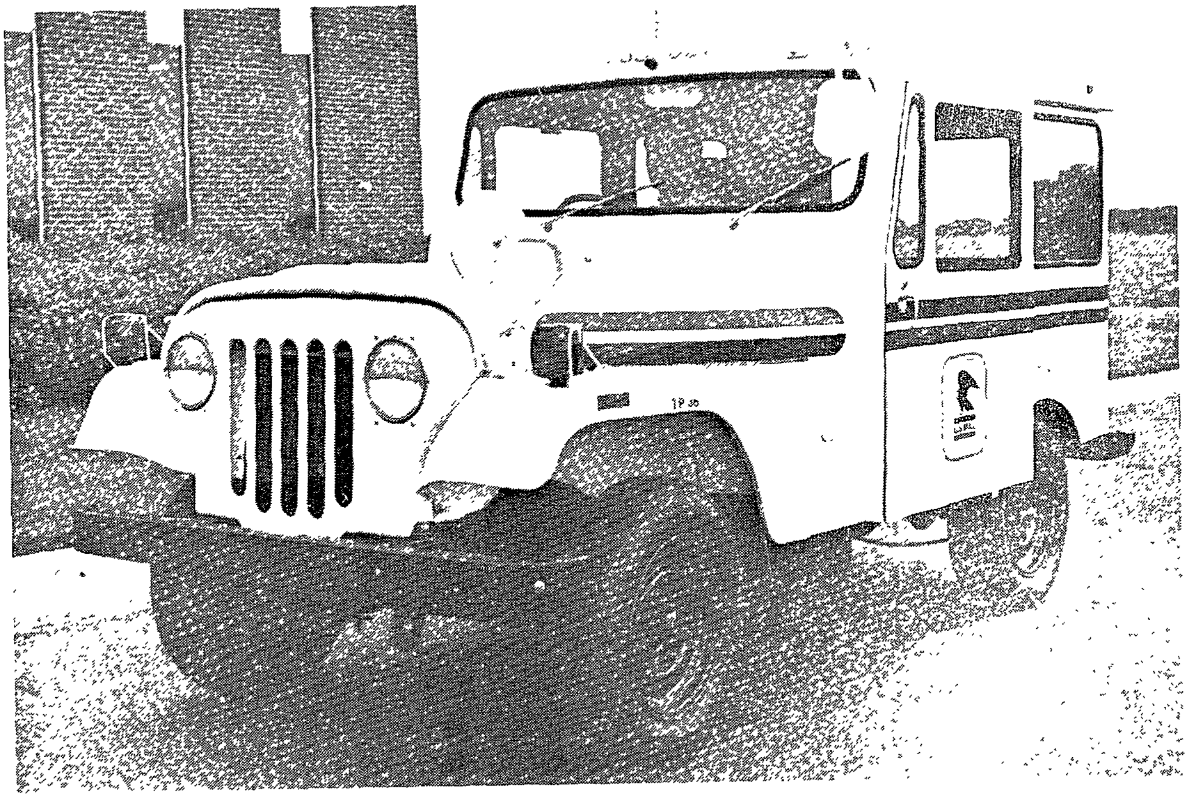
The pictures on pages 2 and 3 illustrate several types of off-the-road and on-the-road electric vehicles.

ADVANTAGES AND DISADVANTAGES OF ELECTRIC VEHICLES

Electric vehicles have many potential advantages over conventional vehicles. They (1) operate free of exhaust fumes--although they indirectly contribute to air pollution through utility power plant emissions, (2) can use an alternative energy source to gasoline, (3) may conserve energy, (4) are expected to be more reliable, and (5) are likely to be less expensive to operate and maintain than conventional vehicles.

On the other hand, electrics have several major disadvantages compared to conventional vehicles. First, performance limitations restrict use to special purpose applications, such as short-range delivery vehicles or short-range commuter cars. Second, acquisition costs for on-the-road electric vehicles can be as much as two to three times higher than conventional vehicles; battery replacement costs can also be high. Third, use of electrics may require retraining mechanics who are not familiar with the electric drive train and, at present, long lead times for spare parts may cause excessive out-of-service time.

OFF-THE-ROAD VEHICLES



ON-THE-ROAD VEHICLES

The primary component restricting electric vehicle performance is the battery. Currently, low battery energy densities restrict vehicle range and limited power outputs restrict acceleration, top speed, and hill climbing ability. For example, as much as 500 pounds of battery may be required to provide the mechanical energy obtainable from a single gallon of gasoline. The equivalent of a 10-gallon gas tank is therefore prohibitively heavy.

Limited performance restricts electric vehicles to special purpose applications

Today's electric vehicles are restricted to special purpose applications because of their limited performance characteristics. They appear to be ideally suited for low-speed, multistop, fleet applications. Fleet vehicles can be directed to cover a relatively fixed daily range and return to homebase at night where batteries can be recharged and trained mechanics can maintain and repair the electric drive train. Electric motors naturally adapt to low speed, multistop service; energy consumption is minimal because there is no energy consumption when the vehicle is stopped, coasting, or decelerating. For more general uses, the apparent advantages of electrics over conventional vehicles are offset by their short range, slow acceleration, low top speeds, poor hill climbing capabilities and cerain safety hazards as discussed below.

Electric vehicles have a short range

Limited range is the major restriction factor for electrics. Electric vehicle range is not only limited but varies significantly with driving and route characteristics. For example, a 1/4-ton Postal Service jeep used on a route with 300 stops needs its battery recharged after 29 miles. The same vehicle used for continuous driving at about 35 mph can travel 45 miles between rechargings. A 1/2-ton delivery van can have a nonstop range of about 40 miles when driving at 30 mph. At a speed of 50 mph this range is decreased to 26 miles and when operating in a residential driving environment the approximate range is 30 miles.

An electric golf cart can make two 18-hole rounds on flat courses before needing a charge, but can only be used for one 18-hole round if the golf course is hilly. In cold, winter weather vehicle ranges are likely to be less because battery energy storage capacity is estimated to be reduced by about 20 to 25 percent.

<u>Electric vehicles accelerate slowly, have low top speeds, and poor hill climbing capabilities</u>

Electric vehicle acceleration, top speed, and hill climbing ability depend largely on the amount of power available from the battery. Battery limitations restrict power availability to much lower levels than those available for conventional vehicles. Moreover, power availability and vehicle range are inversely related. The higher the available power levels the shorter is the vehicle range. Consequently designers have an incentive to keep electric vehicle power requirements low.

There appear to be no uniform regulations specifying acceleration requirements for automobiles, nor is there any concrete evidence as to whether vehicle acceleration performance has a bearing on accident avoidance. A desirable condition seems to be that motor vehicles should not impede traffic. Studies conducted by the Copper Development Association conclude that to keep up with light urban traffic requires an ability to accelerate to 30 mph in 10 seconds, moderate traffic requires reaching 25 mph in 10 seconds, and heavy traffic requires acceleration to 18 mph in 10 seconds.

We observed that some on-the-road electrics meet the tested acceleration criteria. For example, an electric 1/2-ton van met all three traffic requirements. Others, like the 1/4-ton Postal Service mail delivery van in Cupertino, California accelerated to 20 mph in 9 second and to 30 mph in 15 seconds and thus only meets the heavy urban traffic acceleration rates.

The new electric 1/4-ton Postal Service mail delivery jeep will be slower and will require about 20 seconds to accelerate to 30 mph. The electrics have less than one-quarter the power of the conventional jeep.

Compared to conventional vehicles, on-the-road electrics often have low, top speeds. For example, many conventional light trucks have top speeds exceeding 65 mph, while top speeds of most electric on-the-road delivery vehicles reviewed range from 33 to 50 mph.

Some electrics can climb more than 25 percent grades, but apparently only at low speed. For example, the 1/4-ton electric jeep with a top speed of 33 mph, slows down to 16 mph on a 10-percent grade. Data on a 1/2-ton electric delivery van with a top speed of about 50 mph indicates that the vehicle slows down to about 29 mph on a 5 percent grade, and to 10 mph on a 20 percent grade.

Safety hazards

The electric vehicle batteries may be hazardous in an accident because exposure to diluted sulfuric acid from damaged batteries could cause skin burns or blindness. One study showed that locating the heavy batteries in one large container runs counter to current design trends dictated by safety requirements. Batteries also have been known to explode when improper charging procedures are used or when shorted. Charging and discharging lead acid batteries liberates hydrogen gas which can be ignited by a spark. Vehicle safety experts agree that light weight electric vehicles have definite safety disadvantages in mixed traffic accident situations. In addition, low vehicle top speeds can constitute a traffic hazard when mixed with faster traffic.

Electric vehicles can
contribute to air pollution

Whether or not use of electrics helps reduce air pollution depends on the local characteristics of the electricity power generation process. While electrics do not produce vehicle exhaust gas emissions, they transfer the air pollution emission problem to the electricity generating plant. To the extent that the vehicles use electricity generated from such sources as hydropower and nuclear energy, they do not contribute to air pollution. However, electrics that use electricity generated from coal and oil sources contributes to air pollution.

Electric vehicle use of electricity will vary. One test showed electric vehicles consuming .5 kilowatthour (kWh) per mile. If driven 30 miles a day it would consume 15 kWh daily. A 25-inch solid state console color TV is rated at .18 kWh. If used for 6 hours daily it would use about 1 kWh per day.

In 1974, about 62 percent of the electricity generated in the United States was coal and oil based. While the Federal Energy Administration expects electricity production to double by 1985, most of the new electricity generation facilities are expected to be of the clean nuclear type. Consequently, by 1985 the relative share of such dirty fuels as coal and oil used for generation of electricity, is expected to decrease to less than 50 percent.

The air pollution characteristics of power plants differ from pollution emissions of conventional vehicles in both type of pollutant and in the way the pollutant is emitted into the atmosphere. Power plants are the primary source of sulfur dioxides, a very hazardous pollutant. Power plants also emit large quantities of nitrogen oxides and particulate matter.

The power plant emission process also differs from that of automobiles. The former discharges pollutants generally from tall stacks which are removed from the ground surface while conventional vehicles emit pollutants at the street level. Consequently, the concentration of power plant originated pollutants is usually substantially reduced at ground level due to dispersion in the surrounding air volume.

Power plant pollution extends over wide areas. According to the Environmental Protection Agency:

> "The impact of power plants on air quality varies across the country. In some areas the impact of power plants is relatively slight, but in other areas power plants alone cause primary standards to be exceeded. Use of high-sulfur coal, for example, is predominant in our East-Central States where such coal is mined. The detrimental impact of power plants on air quality in these States is substantial, especially when these States are compared to those where gas or low-sulfur oil is used as a fuel."

Conventional vehicles are primary sources of carbon monoxides, hydrocarbons, and nitrogen oxides. Under appropriate weather conditions hydrocarbons and nitrogen oxides react in the atmosphere to form photochemical smog. Both nitrogen oxides and photochemical smog represent serious health hazards.

Ongoing enforcement of vehicle emission controls is expected to eventually reduce automobile-caused air pollution to secondary importance relative to stationary sources.

A comparison of approximate pollutant emissions in grams per mile is shown in the table below for conventional, as well as, electric light duty vehicles.

Comparison of approximate conventional automobile exhaust gas emission characteristics with electric vehicle equivalent power plant emissions (note a)

Pollutant	Estimated precontrol emissions	Conventional car Federal emission standards (note b) 1975	1977	Electric vehicle equivalent power plant emissions (note c) Coal	Oil	Gas
	(grams per mile)					
Hydrocarbons	8.00	1.50	0.41	0.03	0.03	0.00
Carbon monoxide	68.00	15.00	3.40	0.09	0.05	0.04
Oxides of nitrogen	8.00	3.10	d/0.40	e/4.67 to 1.53	1.70	1.39
Sulfur oxides	0.13	0.13	f/0.13	3.24	2.58	0.00
Particulates	(g)	0.10	f/0.10	e/0.86 to 7.37	0.13	0.03
Total	84.13	19.83	4.44	8.89 to 12.26	4.49	1.46

a/Data obtained from studies sponsored by the U.S. Environmental Protection Agency. Power plant emissions correspond to an electricity vehicle energy consumption of 0.5 kWh a mile, and uncontrolled emissions when burning 1-percent sulfur content power plant fuels; power plant efficiency was assumed to be 35 percent, and electricity transmission efficiency as 91 percent.

b/Emission standards refer to automobile emission levels after a certain number of miles have been driven. New cars have lower emission levels.

c/0.5 percent sulfur content fuel oils would produce one-half the sulfur oxide emission levels shown in the table.

d/The conventional car oxides of nitrogen emission standard of 0.4 grams a mile is likely to be revised upward.

e/Bituminous coal with 5.1 percent ash content. Emission levels vary with boiler type. Coals which emit higher levels of oxides of nitrogen emit lower levels of particulates.

f/The Environmental Protection Agency issued no standards regarding automobile sulfur dioxide emissions.

g/We obtained no data regarding automobile particulate emissions before adopting Federal emission standards.

The differences in pollutants emitted by the two types of vehicles are clearly visible. When power plant emissions are uncontrolled, electric vehicles can give rise to more than 10 times the amount of sulfur oxides emitted a mile than conventional vehicles. Emissions of oxides of nitrogen and particulates are also high, while hydrocarbon and carbon monoxide emissions are negligible.

According to a representative of the Environmental Protection Agency, power plant particulate emissions often do not represent a problem because stack gas screening devices have been fairly successful. However, the removal of sulfur and nitrogen oxides from the stack gases is more difficult.

Many utility companies comply with sulfur oxide emission requirements by using scarce, low sulfur levels. For example, in Los Angeles where natural gas shortages recently forced a switch to low sulfur fuel oil, local regulations required using 0.5 percent or less sulfur content.

Electric vehicles can use an alternative source of energy to gasoline, but they are not always energy conserving

Electric vehicles consume energy in that the electricity required to recharge batteries is derived from energy consuming power plants. However, one argument for electric vehicles is their potential for using an alternative energy source to gasoline. This is expected to be particularly important in the future when, according to the Federal Energy Administration, electricity generation is expected to be primarily coal, hydropower and nuclear power based. In 1972 more than 60 percent of the electricity produced in the United States was derived from such sources and it is expected, that by 1985, plants using fuel oil and natural gas will decrease and more than 75 percent of the electricity will be derived from these alternative energy sources.

When electrics replace high performance conventional vehicles they can conserve energy. For example, tests indicated that a conventional 1/4-ton Postal Service mail delivery jeep in Cupertino, California, consumes approximately 21,000 British thermal units per mile while the electric vans, which replaced the jeeps, on the average consume only about 13,900 1/ British thermal units per mile. This represents a

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1/In arriving at the cited figure we considered the energy lost to convert fossil fuels to electricity at power plants, as well as the energy loss in transmitting electricity from the power plant to the point of use.

decrease in energy consumption of approximately 34 percent. The difference is largely based on weight to power ratio considerations. The jeep has about five times the acceleration capability of the electric van and fast accelerations are energy wasteful.

According to the Environmental Protection Agency, if internal combustion engine vehicles were to be designed to offer a reduced performance equivalent to that of electric vehicles, conventional cars could provide equal or better fuel economy. A study regarding the impact of future use of electric cars in the Los Angeles basin found that the lead-acid battery car consumes more energy per mile than conventional subcompacts, such as the 1974 Pinto. The lead-acid electric car was estimated to consume about 8,000 British thermal units per mile (inefficiencies of the power plant and the distribution system were considered) versus about 6,000 British thermal units for the Pinto. Modest improvements in energy consumption efficiencies offered by advanced batteries are likely to be offset by engineering improvements in conventional car design.

<u>Electric vehicles may or may not be economically attractive for Government use</u>

From an economic viewpoint, the electric vehicle may offer advantages over conventional vehicles in lower maintenance and energy costs, and higher reliability. Disadvantages are often high first costs, high battery replacement cost, relative inflexibility concerning variable task assignments, and the potential need for training auto mechanics so that they can diagnose and repair problems of electric drive trains.

The absence of reliable electric vehicles life cycle cost data makes detailed cost analysis impractical. A cost study by one vehicle manufacturer indicates that electrics tend to be economically attractive if (1) acquisition costs are less than about 200 percent of equivalent costs for conventional vehicles, (2) electricity cost is three cents per kWh or less, (3) gasoline costs are about 57 cents per gallon or higher, and (4) maintenance costs for electrics are about one-half those of conventional cars. Using these criteria we noted that off-the-road electrics, such as in-plant type vehicles, and low-cost, on-the-road vehicles would be economical to use at some Federal installations. These vehicles have acquisition costs comparable to the conventional vehicles they replace and annual battery replacement costs are relatively low. On the other hand, many on-the-road vehicles, such as the 1/4-ton electrical Postal Service jeep, an electric 1/2-ton delivery van, and a 25-passenger electric bus are estimated to be economically unattractive. Based on the above considerations, high acquisition costs for these vehicles are not likely to be offset by lower maintenance and energy costs.

On-the-road electrics may have acquisition costs more than twice as high as conventional vehicles purchased by the Government because (1) the electric vehicle drive train is often more costly, (2) the vehicles are often of sturdy, high quality construction, and (3) electric on-the-road vehicles are usually hand built because of low demand.

For example, the cost of conventional gasoline powered three-wheel trucks, two-passenger electric cars and in-plant electric trucks (all off-the-road vehicles) ranged from about $2,000 to $2,500. The cost of a conventional 1/2-ton pick-up truck was about $3,100. Recently 350 electric jeeps (on-the-road vehicles) were purchased by the Postal Service at a unit price of $5,595 at a time when the conventional jeep was costing them $2,175.

Acquisition costs for electrics also often include costs of batteries, battery charger, extra batteries, and equipment needed to exchange batteries. Not included is the cost of constructing a charging facility. If required, this cost can be substantial. For example, in one instance a bus company had to pay an unexpected $40,000 for construction of a charging facility for three electric buses.

In general, electric vehicle repair and maintenance costs vary with vehicle type, usage, and age. According to one manufacturer average maintenance costs can be assumed to be approximately one-half those of conventional cars. For example, national average data on electric forklift trucks indicate that maintenance material costs are 45 to 53 percent lower than for gasoline powered units. Also, maintenance labor costs are 30 to 39 percent lower. Electric vehicle maintenance costs are lower primarily because they have fewer moving parts and no requirements for tuneups, oil changes, or other periodic services normally associated with internal combustion engines.

According to published data, maintenance cost variations associated with electric milk delivery trucks in Great Britain indicate variations ranging from 56 percent cost reductions, to 2 percent cost increases, when compared to conventional trucks. One theoretical study points out that removal of the internal combustion engine system would eliminate about 72 percent of the car service labor hours. Added service requirements of the electric power train are expected to be minimal except perhaps for battery service requirements.

The total battery replacement costs to be incurred during the electric vehicles anticipated life span are often not known because of uncertain battery life expectancies. Battery life depends strongly on usage characteristics. Two types of batteries are being used. Light vehicles often use a series of automotive batteries which are relatively small. In 1974 the Federal Government paid about $180 to replace a battery set. Life expectancy is about 1 year. Heavy vehicles such as buses, delivery trucks, or the 1/4-ton Postal Service jeeps use semi-industrial type batteries which are relatively bulky and cost from about $1,600 to $6,000 a set. The latter batteries have life expectancies ranging from about 4 to 6 years.

Electric vehicles are likely to be more reliable

Electric vehicles are considered to be more reliable than conventional vehicles because the electric drive train has fewer moving parts, fewer vibrations, and the motor provides slower vehicle acceleration. Electric vehicle traction motors have only two metal-to-metal moving parts, and they have a record of high reliability.

For example, during almost 1 year of operation the U.S. Post Office in Cupertino, California experienced only 11 days when any of its 30 electric ~~mail~~ delivery vans were out of service. This amounts to an out-of-service time percentage of approximately one-tenth of 1 percent. According to the Postal Service's western region vehicle service manager this downtime was considerably less than that of conventional jeeps.

USE OF ELECTRIC VEHICLES IN FEDERAL SERVICE

Special purpose electric vehicles, such as material handling forklift trucks and golf carts, are already in service on Federal installations on a routine basis. Other types of on-and off-the-road electric vehicles have performance characteristics which would favor their use, but the absence of reliable cost data makes it difficult to measure their economic attractiveness.

Various agencies have experimented with electric cars. For example, the Air Force assessed potential use of in-plant and on-the-road electric vehicles for on-the-facility use in 1970 and 1971. They concluded that off-the-road electrics, with 10 to 13 mph top speeds, might be economically usable in areas with 15 mph speed limits. Some potential tasks would be transporting flight crews and maintenance equipment in flight line areas, and nighttime security patrols in housing areas. It was also concluded from the tests that electrics could not replace conventional vehicles for some of the work tasks. The Air Force also tested an electric on-the-road delivery van and a 11-passenger bus but recommended against using the vehicles primarily because of the high purchase price and operations costs.

The National Park Service in Washington, D.C., is testing more than 15 off-the-road electrics as well as an on-the-road 25-passenger bus. Vehicle performance appears to be adequate, but operations costs are not being monitored.

The Goddard Space Flight Center has been experimenting with two 12-mph, off-the-road electric vehicles to provide transportation for maintenance supervisors. The electrics replaced a conventional station wagon and a privately owned car. Users are apprehensive about personal safety while driving the low-speed electrics on facility roads which have 25 mph speed limits. In addition, the drivers mentioned that the small electrics slow down to objectionable slow speeds when driving up hill.

The National Oceanic and Atmospheric Administration has been using 3 electrics for about 3 years. Top speed of the vehicles is 28 mph and use has been confined to facility roads. Performance and maintenance requirements have been judged adequate but operation and maintenance cost records have not been kept.

In addition, the U.S. Postal Service has been evaluating the feasibility of using electrics for residential mail delivery service for many years. Feasibility from a performance point of view has been demonstrated for selected routes but operational evaluations are still in process. Unit lease costs, incuding energy and maintenance for 30 on-the-road experimental vans used for mail delivery in Cupertino, California, are about $7.50 a day. In contrast, the Postal Service average for a conventional mail delivery car lease costs is only $3.00 including fuel cost.

To assess electric vehicle characteristics under fleet operating conditions, the Postal Service has ordered 350 electric on-the-road jeeps. If on-the-road electrics prove successful, the Postal Service estimates that vehicles on more than 30,000 mail routes could be replaced by electrics.

We believe that further potential exists for using electric vehicles on Federal installations. For example, relatively high performance, conventional vehicles used for on-the-facility short range applications at three Department of Defense facilities are shown in the table below.

Examples of conventional vehicles potentially replaceable by electric vehicles

Facility	Vehicle type	Number of vehicles in class	Vehicles estimated to be potentially replaceable by by electrics (note a)	Average daily mileage	Vehicle application and comments
McClellan Air Force Base	29-passenger bus	17	11	49	On-the-facility bus service
	1-ton metrovan	40	40	22	Used for mail distribution, aircraft maintenance, and delivery of flight crews on base.
	1/2-ton pick-up	124	62	46	Onbase repair parts and cargo distribution; security patrols.
Fort Ord Army Base	3/4-ton engineering utility truck	126	63	b/17	Onbase maintenance and repairs.
	1/2-ton pick-up	150	85	40	Onbase cargo transportation and personnel transportation; messenger service
Long Beach Naval Shipyard	3/4-ton utility truck	29	12	26	Onbase maintenance and repairs.
	1/2-ton pick-up	116	50	45	Onbase delivery service; personnel transportation; security police.
	3-wheel, low-speed truck	41	41	c/13	On-the-facility messenger and light repair service

a/Criteria: Maximum daily use would be 40 miles and top speed requirement would be 25 miles per hour.

b/Based on a sample of 10 vehicles.

c/Based on a sample of four vehicles.

The table contains estimates of the number of vehicles which could be used exclusively onbase. The average daily mileages shown include long distance offbase driving. Vehicles used only onbase can be expected to have shorter average daily travel requirements. For example, at McClellan Air Force Base most 1-ton metrovans are used for onbase functions such as mail handling, moving flight line aircraft maintenance tools and equipment, and transporting flight crews. Average daily mileage requirements are only 22 miles. On the other hand, many 1/2-ton pick-up trucks have missions which require offbase driving and the average daily trips are much longer.

Speed limits on the three military installations visited varied from about 8 to 35 mph. Generally, speed limits were 25 mph, except at the Long Beach Naval Shipyard where the speed limit on the main thoroughfares was 20 mph. In special purpose areas, such as Air Force industrial areas and along the flight line, speed limits were 15 mph. On the other hand, speed limits on some facility approach areas seemed too high for many electric vehicles.

CONCLUSIONS

Acquisition costs for off-the-road electric vehicles are generally comparable or lower than the cost of conventional vehicles they could replace. However, acquisition cost for some on-the-road electrics such as the electric Postal Service jeeps, is over twice as much as comparable conventional vehicles currently used by Federal agencies. Acquisition cost is high because the electric drive train is more costly to manufacture than the drive train of conventional cars and battery costs are high. When electric vehicles replace conventional vehicles there is also a need for additional auxiliary equipment such as a battery charger, battery exchanger, and a battery charging facility.

It is estimated that electric vehicle maintenance and energy costs are considerably lower than those for comparable conventional vehicles. However, except for special cases, reliable operations and maintenance data is lacking for life cycle analysis and does not allow a realistic economic cost assessment.

Many high performance conventional vehicles are being used by Federal agencies to conduct tasks which could be handled with vehicles of lower performance characteristics. From a performance point of view we see no reason why these vehicles could not be replaced by electric vehicles or equivalent low performance gasoline powered vehicles. Use of low performance vehicles, wherever possible, would result in lowered energy consumption, and in lower air pollution levels. Several Federal agencies have initiated independent experimental programs to assess usefulness of electric vehicles in their operations.

SCOPE

Our examination of the potential for using electric vehicle in the Federal Government included visits to three military installations, two Postal Service sites, and facilities of three Federal civil agencies. Our observations are based on interviews, examination of records, and a review of pertinent documents. In addition, we contacted representatives of pertinent Federal agencies, two trade associations, five electric vehicle manufacturers, and potential commercial and municipal electric vehicle users. We also reviewed numerous publications depicting the current state of the art for electric vehicles.

Entities contacted are shown below.

McClellan Air Force Base
Sacramento, California

Fort Ord Army Base
Fort Ord, California

Long Beach Naval Shipyard
Long Beach, California

Postal Service sites at
San Bruno, California
Cupertino, California

Goddard Space Flight Center
National Aeronautics and Space Administration
Greenbelt, Maryland

National Park Service
Washington, D.C.

National Oceanic and Atmospheric Administration
Washington, D.C.

Department of Transportation
Washington, D.C.
San Francisco, California

Environmental Protection Agency
Washington, D.C.
Ann Arbor, Michigan
San Francisco, California

National Science Foundation
Washington, D.C.

The Electric Vehicle Council
New York City, New York

The Battery Council International
Burlingame, California

Various commercial companies and city transportation departments

Various electric and conventional vehicle manufacturers.