

Commercially Available Electric Tram Evaluation

Evaluation Results

Fish and Wildlife Service (FWS) In-Service Testing



February 2017

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U.S. Department of Transportation
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Background

The promise of a quiet, zero-emissions vehicle to provide transportation services within Fish and Wildlife Service (FWS) locations was first realized in 1994, when the Defense Advanced Projects Research Agency (DARPA) provided an experimental electric tram to the Patuxent Research Refuge (Patuxent) in Maryland. The tram was an instant success with visitors praising the quiet operation and open-air experience of the electric tram.

In 2006, after operating their DARPA electric tram for 12-years, Patuxent applied for funding to replace it. Refuge staff recommended funding the development of a new, specialized tram designed to meet engineering specifications based on the Patuxent's transportation needs.

The agency's headquarters expanded the scope of the project to include identifying existing low-environmental impact trams that could be used on refuges and public lands throughout the U.S. (including the Patuxent Research Refuge and FWS Region 5). A portion of the funding was used to carry out research into commercially available low-environmental impact options.

Commercially available electric vehicle options are limited; however two vehicles were identified as viable alternatives to a prototype vehicle. FWS successfully procured two CitEcar 15-passenger enclosed trams (Figure 1), and three Specialty Vehicles 8-passenger Eco Star Shuttle trams (Figure 2).



Figure 1: CitEcar 15-passenger Tram (image source: CitEcar)



Figure 2: Specialty Vehicles 8-passenger Eco Star Shuttle (image source: Specialty Vehicles)

The FWS placed the trams in service at the following locations in early 2012:

- **CitEcar 15-passenger tram** – St. Marks National Wildlife Refuge (NWR), St. Marks, FL
- **CitEcar 15-passenger tram** – Pelican Island NWR, Vero Beach, FL
- **Eco Star Shuttle 8-passenger tram** – South San Diego Bay NWR, Chula Vista, CA
- **Eco Star Shuttle 8-passenger tram** – Ottawa NWR, Oak Harbor, OH
- **Eco Star Shuttle 8-passenger tram** – Don Edwards San Francisco Bay NWR, Alameda, CA. This vehicle was later transferred to **Sacramento NWR** in Sacramento, CA, as the routes at Don Edwards required traveling on public roads and the trams are not street legal or able to travel at speeds above 25 mph.

In-Service Results

After a calendar year, FWS utilized the shuttles at each test location through their respective peak seasons. The Specialty Vehicles tram placed in service at Don Edwards NWR was unable to be utilized heavily due to the nature of the refuge's layout, which required the vehicle to be transported on a trailer between locations as it was unable to travel on public roads due to top speed limitations. Also, the tram is classified as a low speed vehicle (LSV), which are not street legal. Mid-way through 2013 the tram was transferred to Sacramento NWR, which provided the opportunity to utilize the tram more frequently within a refuge's interior roads and trails.

Collectively, the trams have been well-received and are liked by visitors and staff alike for their easy and quiet operation, which is particularly important to groups eager to view birds and other wildlife that are sensitive to noise. The Specialty Vehicles tram and the CitEcar, while similar in design and layout, have achieved varying results, which are summarized below and presented by vehicle type.

CitEcar 15-passenger tram

St. Marks NWR was the first refuge to initiate use of their CitEcar tram. By June of 2013 they had been able to attempt to use the tram in various roles and purposes. St. Marks NWR supplied the following feedback: The shuttle is not quite up to our expectations, the tram can't quite carry the advertised passenger load of 15, but we love it, and are finding ways to use it. So far we have had zero problems or maintenance issues; we simply plug it in to charge.

Pelican Island NWR was able to put their CitEcar tram through its paces during winter of 2012 during their peak season and in January of 2013 summarized their experience. The refuge explained they have two identical trams, one in white and the other in beige, the latter of which is the tram acquired as part of the pilot study. Both trams are CitEcar 15-passenger trams and were sourced from the same vendor. The beige tram has had issues with batteries requiring maintenance (water level) and replacement, which could also be tied to charging issues experienced early on. They have serviced the tram at local golf cart shops who have indicated the build quality of the tram was poor. The battery terminals tend to corrode easily, likely due to the sea-side environment, and frequently leave corrosive residue in the maintenance shop after storage or repairs. The refuge further compared their two identical trams and noted the tram acquired as part of the pilot study has had issues since they received it, paramount among them has been excessive noise and rolling resistance on deceleration (without brake application). The white tram acquired outside the scope of the tram study, is identical to the beige tram but has proved more reliable and is used frequently. However, while they enjoy utilizing the tram whenever possible, experience has shown ***the trams are neither large enough nor capable or reliable enough to utilize for regular, extensive service***. As such, Pelican Island utilizes the white tram for small group transportation and has been utilizing the beige test tram as a "run about" for errands or to transport visitors when needed as an alternative to a traditionally fueled vehicle.

Conclusions

One of two CitEcar trams procured for the evaluation has had quality issues since delivery. Build quality issues may be due to lax manufacturing and quality control. While the trams are prepared for sale and partially assembled within the U.S., the CitEcar trams were manufactured overseas and do not have a strong manufacturer support system, leaving Pelican Island to rely on local golf-cart repair facilities for maintenance, troubleshooting and repairs. Both trams in the evaluation have shown that when in working condition, they are limited in capability and cannot carry 15 passengers as advertised. The maximum passenger capacity is more realistically eight adult passengers.

Eco Star shuttle 8-passenger tram

South San Diego Bay NWR has been utilizing their Eco Star shuttle for on demand transportation and as a parking shuttle since August of 2012. The shuttle travels a 1.5 mile-route of paved asphalt and pea-gravel parking lots providing transportation services two to three times per week. The trip takes 10-15 minutes, depending on how many visitors need a ride. The refuge has plans to expand service by widening paths within the refuge to allow the tram to safely travel along them. After initial delivery, the tram experienced charging issues that were traced back to an undersized outlet. The circuitry was therefore upgraded from a 20-amp service to a 30-amp service, which has resulted in no further issues with charging the vehicle. The refuge has not had any mechanical issues and have not replaced any parts throughout their trial service. Overall, the tram has limited off-road capabilities and limited passenger capacity, but provides adequate performance and reliability of the tram has been good. Visitors appreciate the quiet, open-air experience and they are hoping to expand service to include tours of the refuge once upgrades to their trail system are completed.

The layout of Don Edwards NWR was not conducive to fully utilizing the tram, as several public roads with speed limits exceeding the tram's capabilities connect various areas of the refuge. In lieu of trailering the shuttle from one location to the other, it was transferred in June of 2013 to Sacramento NWR in order to be more fully utilized along their auto tour route, which is entirely within the boundaries of the refuge. Sacramento NWR experienced recurrent charging issues when they first received the tram, which culminated in one burned-out electrical outlet and plug (Figure 3). The issue was identified as an undersized outlet, and like South San Diego Bay NWR, a 30-amp circuit and updated outlet were installed which solved the charging issues. Unfortunately, the original charger provided with the vehicle suffered damage and a replacement unit provided by Specialty Vehicles appears to have been incompatible with the tram (the original chargers are no longer available for this model). The tram and both chargers were transported to a local specialty golf cart repair shop where the original charger was found to have suffered a component failure. A replacement part was sourced from Specialty Vehicles and the original charger was repaired. In early 2015, the refuge indicated they are excited to utilize the tram in lieu of an 8-passenger van for their auto tour and aside from the early charging issues and frustration with technical support offered by Specialty Vehicles¹, they have not had any mechanical failures or replaced any components of their Eco Star shuttle.



Figure 3: Burned plug and outlet at Sacramento NWR

¹ Specialty Vehicles indicated the shuttle purchased for the evaluation was an older design that has since been updated. A new, universal charger is now used for their current trams but was found incompatible with the earlier tram in use at Sacramento NWR.

In February of 2014, Ottawa NWR summarized their experience with their Eco Star shuttle in a conversation with Assistant Refuge Manager Eddy Pausch:

The tram has been a good cart to shuttle people around, however it has stopped a number of times with a dead battery that required the tram to be towed back to the maintenance shed and plugged back into the charger. We would expect it to run out of power when used heavily, however at times we have thought the tram had sufficient power and it would die about halfway out on the trip. You would charge the vehicle overnight, but at times the charge-level gauge is difficult to interpret how much of a charge you have or how long the vehicle would last. It seems to deplete the battery quicker at certain times versus others. Beyond some initial teething problems with the charging system and running out of battery power, we have not had significant mechanical or maintenance-related issues. The charging system is not terribly intuitive and several people were attempting to charge the vehicle; we have since left charging responsibilities to our maintenance manager as he is the most familiar with the vehicle and charging system. Otherwise the vehicle is liked by all, enjoyed for running around. However, when it's fully loaded with 8 passengers, it seems to lack a bit of power compared to the expected passenger loading. Ideally it would be nice to have a bigger vehicle with a larger power supply capable of taking groups on full tours while fully loaded. It has been a very welcome addition to our fleet and we were using it last May a lot, however we have since realized its limitations, primarily with range issues. During the time period where it was used almost every day, it was running along a 2-3 mile loop, some paved but mostly gravel and dirt. During that time of daily use was when we experienced problems.

He further explained that Ottawa NWR intends to utilize the vehicle for small group tours, as an on demand shuttle, and generally utilize the tram for infrequent and conservative means.

Conclusions

First and foremost, operators of the Eco Star shuttle have experienced early-use problems with the charging systems, most of which could have been prevented with adequate planning. It is strongly recommended that all future operators of Eco Star shuttles complete manufacturer training on the charging system and provide a dedicated outlet on a 30 amp² circuit for the charger. Manufacturer supplied charging components should not be modified or altered without consulting the manufacturer. Installing charging infrastructure or performing upgrades to existing electrical services should be carried out by a licensed electrician prior to vehicle deployment.

Beyond these initial issues with the charging system, overall vehicle performance of the Eco Star shuttle is not suitable for heavy, regular service, particularly if the vehicle is at maximum capacity, as range and performance appear to suffer. The shuttles are most well-suited for occasional transportation of small groups such as birding tours or as a means for staff to move throughout the refuge and transport other staff or equipment. In this role, the electric shuttles perform adequately to replace a traditionally fueled vehicle.

² A 30-amp service is required for the Eco Star shuttles tested during the evaluation. Future shuttles may have different requirements for their charging system. An appropriately sized outlet must be provided to meet manufacturer requirements, consult a local electrician and vehicle manufacturer prior to making any attempts to charge the vehicle.

Summary of in-service experience

Prior to purchasing an electric tram, consider implications on power consumption of tram accessories or features as some accessories like headlights consume significant amounts of power. Consider the route or anticipated deployment environment; small electric trams require paved or well-groomed, non-asphalt roads for operation and do not perform well in “off-road” settings or climbing significant grades. Small electric trams should be considered for transport of small groups, such as birding tours; as a light-duty parking shuttle; or as a “runabout” vehicle for staff to replace traditionally fueled vehicles such as cars or small sport utility vehicles. Electric trams built off a golf cart platform are generally not suited for transportation of groups over 10 and may not offer sufficient power to provide regular shuttle service for an entire day if demand is high and requires frequent trips.

Current Electric Tram Market

Despite their limitations, small electric trams are becoming more widely available. Nearly twenty different variants of trams for up to eight passengers are currently available to purchase through GSA directly as part of [Schedule 23 V](#) under category 023 LSV. Equivalent trams available through GSA are detailed in Table 1, below. As more models are becoming widely available, it is reasonable to expect that build quality and parts and manufacturer support will improve.

Table 1: Electric trams available through GSA Schedule 23V

Manufacturer Model Name	Relevant Specification	Pricing
E-Ride Industries EXV2AC Patriot People Transporter	Max Pax: 8 Max. Speed: 25 mph 72 V, 16.5 hp DC motor Dual Voltage- 115/230 AC Input	\$24,660.71
CITECAR ENB-8P	Max. Pax: 6 front + 2 back Max. Speed: 25 mph 4kW/5.5 hp DC motor Range: 50 miles	\$8,882.12
JH Global Services, Inc. Star EV 48-8SF-HYD	Max. Pax: 6 front and 2 back Max. Speed: 20-25 mph Max. Load: 900 lbs. 4kW/5.5 hp DC motor Range: 45-50 miles	\$10,108.00
Cruise Car, Inc. Sunray Series M6S-LSV Solar New	Max. Pax: 6 Max Speed: 20-25 mph 18 hp motor and 230 W solar panel	\$16,025.44
Cruise Car, Inc. Sunray Series M8BTB-LSV Electric New	Max. Pax: 6 and 2 back Max Speed: 20-25 mph 18 hp motor and 230 W solar panel	\$16,025.44
Cruise Car, Inc. Vector Series M8BTB-LSV Electric New	Max. Pax: 6 Max Speed: 20-25 mph 18 hp motor	\$13,153.90
Cruise Car, Inc. Vector Series M6-LSV Electric New	Max. Pax: 6 Max. Speed: 20-25 mph 18 hp motor	\$13,153.90
CITECAR EBB LSV 6 Passenger Deluxe Shuttle 6.7 HP EBB-6PDLXU	Max. Pax: 6 Max. Speed: 25 mph 6.7 hp motor Range: 35 miles On-board charger	\$14,504.28
JH Global Services, Inc. 48V-6 Passenger LSV Car	Max. Pax: 6 Max. Speed: 25 mph 7 hp motor Range: 50 miles	\$10,741.00

Manufacturer Model Name	Relevant Specification	Pricing
Polaris Sales 2014 Polaris Gem E6	Max. Pax: 6 Max. Speed: 25 mph 7 hp motor Range: 50 miles	\$13,329.02
Polaris Sales GEM E6S	Max. Pax: 6 Max. Speed: 25 mph 7 hp motor Range: 30 miles	\$13,995.52
CITECAR EBB LSV 8 Passenger Roadster 10.1 HP	Max. Pax: 8 Max. Speed: 25 mph 10.1 hp DC motor Range: 50 miles (on board charger)	\$15,411.08
CITECAR EBB LSV 6 Passenger Roadster 10.1 HP	Max. Pax: 4 front and 2 back Max. Speed: 25 mph 10.1 hp DC motor Range: 50 miles (on board charger)	\$14,957.68
CITECAR GT Aluminum 6 Passenger RF LSV Golf Cart	Max. Pax: 4 front and 2 back Max. Speed: 25 mph 5.5 hp DC motor Range: 50 miles (on board charger)	\$9,788.92
CITECAR ENB LSV 6 Passenger Back to Back HR	Max. Pax: 4 front and 2 back Max. Speed: 25 mph 5.5 hp DC motor Range: 50 miles (on board charger)	\$10,333.00
CITECAR EBB LSV 6 Passenger RF	Max. Pax: 4 front and 2 back Max. Speed: 25 mph 5.5 hp DC motor Range: 50 miles (on board charger)	\$9,335.52
JH Global Services, Inc. Open Style 6 Passenger Electric Police Vehicle	Max. Pax: 6 Max. Speed: 20-25 mph 7 hp DC motor Range: 50 miles (on board charger)	\$14,244.00
JH Global Services 48V 6 Passenger Short LSV	Max. Pax: 4 front and 2 back Max. Speed: 20-25 mph 5.5 hp DC motor Range: 45-50 miles (automatic charger)	\$8,340.00

According to their websites, trams similar to those tested as well as new models are available from [citEcar](#) and [Specialty Vehicles](#). These trams are detailed in Table 2 and Table 3 below.

Table 2: Electric trams available through CitECar

Model Name	Relevant Specification	Pricing
15 P Electric Shuttle	Max. Pax: 15 Max. Speed: 25 mph 5 kW DC motor Range: 50 miles Max. Load: 25000 lbs.	\$17,995.00 + shipping
ADA Electric Shuttle 11P 1WC	Max. Pax: 11 and 1 wheelchair Max. Speed: 25 mph 7 kW DC motor Range: 50 miles Max. Load: 2500 lbs.	\$24,995.00 + shipping
Transport Buddy 9P	Max. Pax: 9 Max. Speed: 25 mph 5 kW DC motor Range: 50 miles Max. Load: 1200 lbs.	\$14,995.00 + shipping
Bubble Buddy 6P	Max. Pax: 6 Max. Speed: 25 mph 4 kW DC motor Range: 50 miles Max. Lad: 1000 lbs.	\$10,795.00 + shipping
6PF Street Legal Golf Cart	Max. Pax: 6 Max. Speed: 25 mph 4 kW DC motor Range: 50 miles Max. Load: 1050 lbs.	\$8,995.00 + shipping
6 PR Street Legal Golf Cart	Max. Pax: 4 front and 2 back Max. Speed: 25 mph 4 kW DC motor Range: 50 miles Max. Load: 1000 lbs.	\$8,495.00 + shipping
6 PR XLC Street Legal Golf Cart	Max. Pax: 4 front and 2 back Max. Speed: 25 mph 4 kW DC motor + solar Range: 105 miles	\$12,595.00 + shipping
8 PR Street Legal Cart AC Motor	Max. Pax: 6 front and 2 back Max. Speed: 25 mph 5 kW AC motor Range: 50-60 miles Max Load: 1,200 lbs.	\$10,995.00 + shipping

Model Name	Relevant Specification	Pricing
Wheelchair 6PR SL Golf Cart	Max. Pax: 4 front and 2 back Max. Speed: 25 mph 5.3 kW DC motor Range: 40 miles Max Load: 1,200 lbs.	\$13,795 + shipping
6PR Street Legal Golf Cart AC Motor	Max. Pax: 6 front + 2 back Max. Speed: 25 mph 4 kW AC motor Range: 50 miles Max. Load: 1,000 lbs.	\$11,995 + shipping

Table 3: Electric trams available from Specialty Vehicles

Model Name	Relevant Specification	Pricing
Eco-Star Shuttle 8 Pax	Max. Pax: 8 Max. Speed: 18 mph 4 kW AC motor Range: 44 miles Max. Load: 1,400 lbs.	\$15,500 + shipping
Eco-Star Shuttle 11 Pax	Max. Pax: 11 Max. Speed: 20 mph 5 kW AC motor Range: 60 miles Max. Load: 1,925 lbs.	\$16,500 + shipping
Eco-Star Shuttle 14 Pax	Max. Pax: 11 front and 3 back Max. Speed: 20 mph 5 or 7.5 kW AC motor Range: 60 miles Max. Load: 2,315 lbs.	\$17,500 + shipping
Wheelchair Position option available for \$3,500		

Conclusions and Recommendations

Almost all electric, battery-powered transportation options promise quiet and zero emissions benefits for transportation within sensitive areas and are of high interest to public lands agencies, which are often charged with preserving the lands within their jurisdictions. Since 1995, the FWS has looked for an electric, open-air tram capable of transporting large groups of people. Unfortunately, the market does not yet offer such a vehicle as a “turn-key” solution at an affordable price. Most offerings available for purchase today, such as those detailed above, and evaluated over the past few years are small, low-speed electric vehicles built off a golf cart platform. Such vehicles are limited in their passenger carrying capacity and are not suitable for moving large groups of people over long distances or across demanding or unpaved terrain. However, the smaller trams offer an opportunity to replace other traditionally-fueled vehicles such as trucks, SUVs, and passenger vans that are largely used for running errands or moving small groups of people.

Provided realistic expectations of passenger capacity and operational limitations are adhered to, the commercially available options detailed above offer an inexpensive solution that can provide real and immediate benefits in terms of reducing noise and environmental emissions as well as fuel use within public lands.

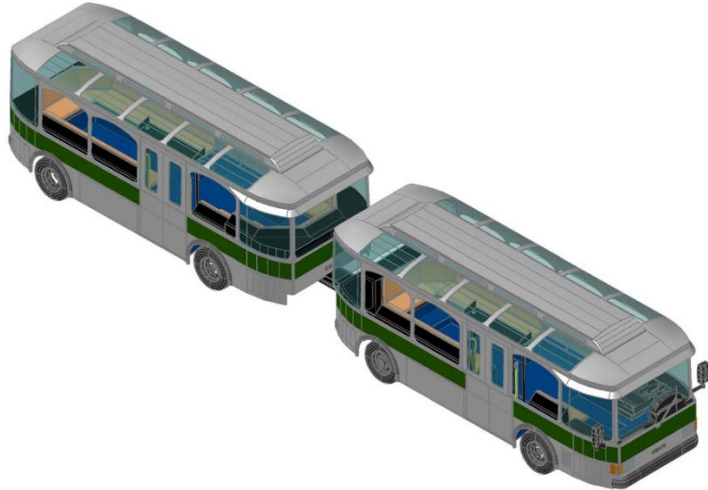
For moving large groups of people such as school groups, in which 40 or more students arrive by bus, an equivalent “open-air” all electric vehicle is not currently available. The FWS attempted to solicit interest in building such a vehicle, but the request for proposals (RFP) was ultimately unsuccessful and did not result in a new vehicle design³. There are some vehicles available today that are close, however options are limited to non-open-air designs that more closely resemble a transit bus or streetcar style “trolley” vehicle. While a new, open-air vehicle is not currently available, the FWS is encouraged to consider revisiting a RFP for such a vehicle but with a more robust cost target. Equivalently-sized battery-electric buses start at \$495,000 and can cost up to \$1,000,000. Future attempts to solicit such a vehicle should consider the robust nature required of large passenger vehicles and the technology costs associated with zero-emission, battery-powered electric vehicles which are higher than their traditionally-fueled counterparts. The FWS should anticipate a per-unit cost for an all-new, open-air, battery-electric tram to be in the range of \$500,000, and that this price point may not include one-time engineering costs associated with developing a prototype. Since unit cost is largely dependent on production volumes, the FWS should identify the level of interest internally or with other agencies.

The marketplace is growing for electric buses, however low speed vehicles remain a relatively niche market due to their inability to travel on public roads where speed limits are often well above the top speeds of LSVs. Road legal vehicles are more often fully-enclosed to meet safety requirements, and in lieu of a true “open-air” vehicle, the FWS and other agencies interested in zero emission, quiet vehicles might wish to explore options that are not open-air. Some manufacturers have preliminary designs for vehicles that are in between a traditional bus and an open-air tram, such as the concept shown in Figure 4 below, provided by eBus. This design is based off an existing bus platform, but features larger windows, including windows at the top of the bus to enhance outward visibility for passengers. The concept also utilizes a trailering configuration, enabling one staff member to drive and interpret for a

³ FWS’ RFP for an open-air tram was tendered with a limited budget; the only respondent to the RFP was under the false assumption the budget was even more limited than it was. The resulting response to the RFP was not for a new vehicle, but to perform a rehabilitation of their existing electric tram. The response was accepted by Patuxent and no further solicitation activities for an all-new vehicle were carried out.

larger audience of up to 50 seated passengers. Such a design may inspire greater interest as the vehicle would be road legal. Estimates for the purchase of the first unit (future units would be less expensive after initial engineering and manufacturing costs) would be roughly \$650,000.

Figure 4 - eBus concept vehicle (sketch was shared in discussions with eBus, www.ebus.com)



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