

Rural School Bus Pilot Project – Applicant Webinar
February 16, 2017
Electric Bus Q&A

Q.What passenger sizes are the zero emissions buses available in?

Creative Bus Sales: Starcraft E-Quest XL School Bus seats up to 47 Passengers with options for Wheelchair equipment and Air Conditioning.

First Priority GreenFleet: The Type-C eLion bus has a seating capacity of between 42 and (a maximum capacity of) 71 passengers; the seating availability depends on the configuration and specifications chosen (A/C, wheelchair positions, preferred WB/chassis length, luggage compartments, etc.) and the seating capacity is reduced accordingly.

The Type-A Trans Tech eSeries bus has a maximum seating capacity of 25 passengers; which would also be reduced based on options chosen.

Q. How many students does each size of the buses hold?

Creative Bus Sales: Starcraft E-Quest XL School Bus seats up to 47 Passengers with options for Wheelchair equipment and Air Conditioning.

Q.I was wanting to know what the largest size electric bus is available. Or can you put me in touch with someone that can answer that?

Creative Bus Sales: Starcraft E-Quest XL School Bus seats up to 47 Passengers with options for Wheelchair equipment and Air Conditioning. You can contact Creative Bus Sales directly at 800.326.2877

First Priority GreenFleet: The largest currently available is the Type-C eLion bus, which has a maximum seating capacity of 71 passengers.

Q.We reside in the foothills and our bus has to travel up and down many hills. How do the zero emission buses handle conditions like this?

Motiv: Different zero-emission buses perform differently, and today's battery electric buses perform better than those of past decades. The E-Quest XL is specified and tested at full GVWR (max student load) to start, stop, park safely and re-start on grades up to 20%. The bus will perform well on up-and-down terrain, using regenerative braking to reduce brake wear and recapture energy on the downhill portions of the drive. On long, steep climbs the bus speed may drop. It is possible that on long, steep climbs on highways, the bus speed may be too slow to meet your driving requirements. If you have some bus routes that you could share, we could evaluate them for fitness for the E-Quest XL.

Q. How will Electric buses do in mountain areas - I have been told they will not do well in my area of Lake County (Kelseyville).

Motiv: Most of Kelseyville and surrounding area looks fine. I did find one hill (Sunset Ridge Drive) near Riviera Elementary School which measures as a grade up to 29%. We would not

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recommend putting an E-Quest XL on a route that included this steep of a hill. If you have some bus routes that you could share, we could evaluate them for fitness for the E-Quest XL.

Q. Rural areas don't have well maintained roadways, how are the buses for these roadways?

Creative Bus Sales: The Starcraft E-Quest XL sits on the Ford F59 Commercial Grade Chassis. This 22,000 GVWR Ford Chassis is proven and works well on all types of roadways.

First Priority GreenFleet: Electric buses are no different than internal combustion engine buses when it comes to ability to handle roadways that are less than ideally maintained. In fact, the reduced vibrations inherent to electric buses will make the ride considerably more enjoyable.

Q. How efficient are zero-emission (battery) school buses in mountainous areas? Is there enough range to consider them?

First Priority GreenFleet: It will be important to have a route profile evaluation completed (mileage needed, grades traversed, number of stops, speed requirements, opportunity charging availability between A.M. & P.M. routes, etc.) to ensure the range requirements of specific routes are able to be met. The regenerative braking component of the electric buses does help maximize the bus range capability and helps recover some of the range loss due to typical mountainous routes.

Motiv: Range of the E-Quest XL is 60 to 85 miles, and depends on the number of batteries (5 or 6 available), driver and terrain. Long, sustained multi-mile hills could reduce range, but if the bus comes back down such a hill, much of the energy is recaptured during regenerative braking.

Q. What about hilly areas? Powerwise?

Motiv: see above

Q. How long does a charge last on daily uses?

First Priority GreenFleet: How long the charge of an electric bus lasts depends more on specific route profile characteristics (miles, grades traversed, highway vs. rural/city routes, heat and/or A/C usage, etc.) than it does on time. Each of the currently available electric school buses has a top range of approximately 100 miles on a single-charge.

Motiv: The charge will last the whole day; 60 to 85 miles of driving.

Q. Are specs available for charging station requirements?

First Priority GreenFleet: Yes. Please contact one of the bus dealers and/or EVSE (Electric Vehicle Supply Equipment) providers to have a site assessment performed and to provide a quote for infrastructure and charging equipment needed for your facility and specific electric bus chosen.

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Motiv: See attached (Contact creative Bus Sales for Attachment) charge station PDF from Clipper Creek. This station is UL certified and is the highest-power charge station on the market without going to DC fast charge (which is very expensive). Passenger cars and other smaller EV's can be charged from this station using an adapter cable.

Q. Do you know the estimated cost to install a charging station?

Creative Bus Sales: It's difficult to give an estimated cost without a site survey. A site survey is key.

First Priority GreenFleet: The range of costs can vary greatly for any needed infrastructure or capacity upgrades, but depending on the EVSE equipment chosen, the cost range of the charging station can typically range anywhere between \$2000 - \$5500.

Q. What is the life cycle of batteries?

Motiv: The batteries are 1500 to 2000 nameplate cycles. One "nameplate cycle" represents the driving to full drain the battery. So, if the battery is fully drained 100% each operating day, the life is 1500 to 2000 operating days. In practice, without mid-day charging, it is impossible to drain the battery 100% each day, so the life is more like 2,200 to 3,000 operating days. For a school year with 180 days, this is 12 to 17 years. With mid-day charging, the battery lifetime may be lower: 8 to 10 years depending on how heavily and regularly mid-day charging is used.

Another way to think about this is that on a 6-battery bus with 127 kWh, 2000 nameplate cycles is 254,000 lifetime kWh. The bus gets 1.0-1.4 kWh per mile, so this equates to 181,000 to 254,000 miles of lifetime.

Q. What is the life expectancy of the batteries and how much do replacements cost?

First Priority GreenFleet: The life-cycle of the batteries depends on the usage profile and cycles performed (number of charges & discharges) over time; typically the batteries are expected to between 10-15 years, but you may see some slight and slow degradation (loss of range capacity) starting around years 8-10. Replacing the batteries after their useful automotive life (10-15 years from now) is expected to be about 25-30% of the current cost of batteries.

Motiv: See above for life expectancy. Battery price is dropping quickly in the market. In 3 years time, we expect the replacement cost for one of the E-Quest XL battery packs to be around \$7,000-9,000 (today it is \$19,000). We also expect other alternative options on the market that are even less expensive and will be compatible with these buses after a wireless, remote firmware upgrade.

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Note that the E-Quest XL has 5 or 6 independent battery packs. All packs function optimally if one is replaced; old packs do not cause a potentially dangerous parasitic drain on new packs. Ever wondered why you aren't supposed to mix old and new batteries in a flashlight? Same principal on electric vehicles. Some of Motiv's unique technology is to independently control each pack so that mixing new and old packs doesn't cause a safety or lifetime concern.

Q. WE currently have GPS on our buses. Are these buses capable for installation of GPS systems?

Creative Bus Sales: Yes. GPS can be installed.

First Priority GreenFleet: Yes.

Q. Who would provide site assessments?

Creative Bus Sales: Contact us directly at 800.326.827. We can help get you to the right person.

First Priority GreenFleet: There are multiple vendors (such as EV Connect) that can provide site assessments; please contact the bus dealers.

Q. I am sorry I think I missed hearing what is the distance range in miles the electric bus operates?

Creative Bus Sales: The Starcraft E-Quest XL can operate up to an 85 mile range on a 127KW Battery Pack.

Q. What is the life span of a zero- emissions bus?

Creative Bus Sales: According to National Association of Pupil Transportation, the Type C Bus is rated at a 12-15 year life cycle.

First Priority GreenFleet: Electric buses are expected to last longer (body & chassis) due to the decrease in vibrations and stresses typically caused by a diesel powertrains. Electric powertrains are also expected to last considerable longer than their internal combustion engine counterparts, but may need to have a battery pack replacement between years 10-15.

Q. Will electric buses work in areas where we are going up to high elevations regularly. Willits, CA

First Priority GreenFleet: The Type-C eLion bus has been rated to handle grades of 20% (at a minimum of 10mph) and the Type-A Trans Tech eSeries bus has been rated to handle grades of 13%. Each of these electric buses are able to have their performance characteristics (torque settings) configured to the specific route profile needs of the school district, including foothills and mountain routes.

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Motiv: High elevation is not in itself problematic, but see above answers regarding steep hill climbing. The Brooktrails residential area north of Willits looks to have some roads with steep grades. If you have some bus routes that you could share, we could evaluate their fitness for the E-Quest XL.

Q. Do the buses meet seatbelt requirements for student seating?

Creative Bus Sales: As of 2005, all new school buses sold and delivered are required to have 3 point seatbelts. The Starcraft E-Quest XL meets these requirements.

First Priority GreenFleet: Yes.

Q. In mountainous terrain, we understand that the mileage capability of an electric bus is reduced. If we could arrange a 3 hour charging period between the morning and afternoon routes, can you give an approximate number of miles we might be able to get for the afternoon route.

First Priority GreenFleet: With a three-hour opportunity charging period (with the proper charging equipment at maximum charging capacity), it would be estimated you could achieve approximately 50-65% of additional range capacity.

Motiv: You could probably add 30 to 45 miles of range per day with this mid-day charge. For example, with a 6-battery E-Quest XL which was driven 60 miles in the morning and returned mid-day with 15% SOC, you would be able to charge back to ~75% SOC, and then would be able to do another 45 miles and still return back with 10% SOC remaining.

The above example uses 1.4 kWh/mile, which is a very energy-intensive route. Many routes, even those with hills, will not drain the battery this quickly.

We routinely see 1.0 kWh/mi and 1.2 kWh/mile on typical routes. On a less energy-intensive route, this example bus might go 75 miles in the morning, return with 15% SOC, re-charge to ~75%, then drive 60 more miles in the afternoon and return with 8% SOC remaining for a total daily drive of 135 miles.

Q. Can these batteries be upgraded after 10 years?

First Priority GreenFleet: Yes.

Motiv: Yes. As better batteries are available, Motiv will validate them with our system. Once a new battery pack is validated, it will be available for all existing customers as after-sales OEM parts. Also, Motiv's software will require a remote firmware update, which Motiv does securely over wifi.

Q. Brett- Is there any preference in batteries that are used in E buses (ex. Lithium vs. Chemical)?

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First Priority GreenFleet: Each battery manufacturer and chemistry has certain characteristics that could be considered more preferable for certain applications and duty-cycles. Each school district should discuss these with the specific bus dealers. Please note that not all chemistries/batteries are available for each type bus.

Motiv: All batteries are chemical in nature. There are many types of battery chemistry. For example, “Lithium” is a family of chemistries which includes Li-NMC, Li-Iron-Phosphate and others. Different batteries have pros and cons, including price, performance, safety, etc. The E-Quest XL uses Sodium-Nickel batteries.

Q. Bus routes in general are not short. We really need the facts on the distance of these electric buses. Most buses travel 130 miles per day or more. Please provide this critical detail.

Motiv: 130 miles would be a challenge for the E-Quest XL. If the routes have low average speed (e.g. lots of stop-and-go) and there is time for a mid-day charge, this range could be accomplished, but it is at the upper ends of what would be achievable. See above answer about mid-day charging.

Q. Any concern that cold weather may shorten battery life? We are routinely below zero in winter.

First Priority GreenFleet: Extreme temperatures are not expected to affect battery life; however, cold temperatures may affect daily ranges that are able to be achieved, especially with consistent heater usage throughout the routes.

Motiv: No, at least not for the E-Quest XL. It’s battery packs are fully thermally managed. There has been a Motiv-powered full size electric garbage truck in service in Chicago for 3 years, through winters, with no degradation on the battery (same battery packs as on the E-Quest XL).

Q. What are the average miles that you are seeing an electric bus going on and name some schools that are using them, from your personal experience?

Motiv: A couple data points:

- Kings Canyon Unified Schools uses Motiv-powered electric school buses and does 40 to 55 mile routes routinely.
- The City of Mountain View, CA uses six Motiv-powered shuttle buses that each do 75 miles daily, 7 days a week.

Q. What is the average distance the electric buses travel on average? We can't stop to recharge for hours halfway through the day.

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First Priority GreenFleet: The buses are capable of up to 100-miles on average on a single charge. So, if there is the opportunity to charge between A.M. & P.M. routes, typical full-day routes of between 140-160 miles are certainly achievable. Please contact the bus dealer for a route profile analysis to ensure mission match for your specific routes can be achieved.

Please contact the specific bus dealers for usage (range) references.

Motiv: 60 to 85 miles.

Q. How long does it take for the battery to fully charge, worse case scenario?

First Priority GreenFleet: Depending on starting SOC (State of Charge), a typical full-charge cycle could take up to eight hours (if the proper charging equipment is not being used, it could take longer).

Motiv: Worst case is 8 hours, if the battery cells need to balance. We recommend allowing the buses a full 8 hour charge window at least every 5 days.

Q. Can you explain how V2G affects the batteries?

First Priority GreenFleet: The eLion batteries are tested for 10,000 cycles of use before they are typically retired. School buses are unique in that they rarely get to that many cycles and adding the School Bus-2-Grid (V2G) function would only add at most 1 cycle per day. So, if a school bus ran every day, (twice a day) to full capacity that would be 2 cycles (adding 1 cycle is irrelevant relative to the use they are spec'd for) and the fact that most buses are used for a mere 120 days per year means that the additional cycles do not add any significant use issues.

Also, it's important to note that Lion Bus has confirmed with LG that adding that function **does not void their warranty.**

Motiv: We would not anticipate supplying these buses with V2G capability, but it would be an upgrade option.

V2G can include different functions:

- Load shifting – this means charging the bus batteries at one time in the day and discharging at another time in the day. The revenue gained here is from buying electricity off-peak and re-selling it on-peak. Depending on your electricity bill and classification, this is typically not a very high source of revenue. This type of V2G will cause cycles to be put on the battery in the same way as driving would. Every 1 to 1.4 kWh of electricity that you re-sell is the same as driving an additional mile. This trade-off is universal across all V2G systems.

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- Frequency regulation – this V2G function requires high peak power, but not a lot of energy. It has less of an impact on battery life, but could heat batteries up considerably depending on their configuration and level of thermal management. Because of the high peak power, some V2G systems do not support this type of V2G functionality.
- Generator market bids – this V2G function would allow the school district to bid into a market (e.g. the hour-ahead market) for selling electricity that has been charged into the bus batteries. Same as load shifting, each kWh supplied has a corresponding impact on the battery just as driving would. This type of V2G requires an entity to bid into the market(s) and control the bus discharge. We (Motiv) do not know of any entity doing this at a commercialized level today.

The exact nature of the V2G is important to understand when trying to determine how it will impact battery aging.