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Micro Bird G5e 140 and 175
Electric School Bus

MICRO BIRD by GIRARDIN



G5e
140 | 175

- **Range Up to 200 Miles (320 Km)**
- **One Pedal Driving / Regenerative Braking System**
- **Optimized Fleet Management with Live Telematic Dashboard**
- **Vehicle to Grid Technology Capable**
- **Smart Vehicle** *(Cabin and Battery Pre-Conditioning)*
- **Lithium Iron Phosphate (LFP) Batteries**

MICRO BIRD,
THE *LEADER* IN THE INDUSTRY
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MICRO BIRD by GIRARDIN

Micro Bird G5e 140 and 175
Electric School Bus

MICRO BIRD by GIRARDIN



POWERED BY ecotuned TECHNOLOGIES

BODY DIMENSION	FORD	
MODEL	AMBULATORY	LIFT BUS
MAX PASSENGER CAPACITY	30	18+1
EXTERIOR LENGTH OVERALL	283″	283″
EXTERIOR WIDTH OVERALL	96″	96″
EXTERIOR HEIGHT OVERALL	113″	118″
INTERIOR FLOOR LENGTH	177″	177″
INTERIOR WIDTH AT HIP	93″	93″
INTERIOR HEIGHT AT CENTER LINE	76″	76″
ENTRANCE DOOR	32″ X 77″	32″ X 82″
SIDE WINDOWS	35″ X 30″	35″ X 30″
CHASSIS		
WHEELBASE	158"	
GVWR	14 500 LBS	
ELECTRIC DRIVE TRAIN		
MAXIMUM SPEED	75 MPH (120KM/H)	
AUTONOMY 140 KWH	150 MI (240 KM)	
AUTONOMY 175 KWH	200 MI (320 KM)	
POWER	335 HP (250 KW)	
TORQUE	1420-FT-LBS (1926 NM)	
GRADEABILITY	25%	
BATTERY		
TYPE	LITHIUM IRON PHOSPHATE (LFP)	
NOMINAL VOLTAGE	600 VOLTS NOMINAL	
CHARGING PORT	SAE J1772 CCS TYPE 1	
CHARGING (100%)		
	140KWH	175KWH
LEVEL 2	7HOURS	9HOURS
LEVEL 3	LESS THAN 1.5H (0-80%)	LESS THAN 1.5H (0-80%)
MAXIMUM CHARGE RATE	100 KW	100 KW
WARRANTY		
ELECTRIC BATTERY	8 YEARS / 100 000 MILES (160 000 KM)	
POWERTRAIN AND ELECTRIC POWER SYSTEMS	5 YEARS / 60 000 MILES (100 000 KM)	
BODY	1 YEAR / 12 000 MILES (20 000 KM)	
STRUCTURE	5 YEARS LIMITED	

OPTIONS

- Audio/P.A. systems
- Back-up sensors
- Aluminum Bumper
- Driver side auxiliary step
- Child Check System
- Optional A/C options
- Integrated child seats
- Lap and shoulder belt seating
- Remote heated mirrors
- Wheelchair and occupant restraint system

And many more...



A WIDE RANGE OF CONFIGURATIONS TO BETTER ACCOMMODATE YOUR NEEDS.

MKB06/24

Specifications shown in this brochure were in effect at the time of printing. In keeping with its policiy of continual improvement Micro Bird Inc, reserves the right to change specifications without incurring obligations.

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MICRO BIRD by GIRARDIN

Z-600 School Bus



Electric Chassis	Built with the Ford E-450 Superduty Chassis Wheelbases: 158″ | 176″ | 190″ **Phoenix** Electric Drive System Safely between frame rails Dual Mode Regenerative Braking Digital Infotainment Display Peak Power: 250kW / 335HP GVWR: 14,500 lbs. GCWR: 17,500 lbs. Chassis Payload Full Integration with Front and Rear HVAC
Body	Noninvasive Drive System Works with Most Major Body Suppliers Type A School Bus Body Up to 30 Passengers / ADA Options Available
Charging System	Universal Charging Level 3: **100kWh** – CCS Level 2: **19.2kWh** – J1772
Batteries	Smart. Safe. Efficient. Proven. Rigorously Tested Using Criteria Validated By a 3rd Party. Liquid Cooling for Active Thermal Management Passive Propagation Resistance (PPR). Defective Cells Isolated from All Others to Prevent Thermal Runaway.
Energy Storage	**Z-500** | 90kWh | Up to 135 Miles in Range Per Charge **Z-500Max** | 131kWh | Up to 165 Miles in Range Per Charge
Acceleration	0-60 MPH 16s
Hill Climb	Max Gradeability 30%
Support	Industry-Leading Training, Service and Support

CE SERIES
ELECTRIC



IC BUS® ECE SERIES SCHOOL BUS

THE NEXT-GENERATION IC BUS® CE SERIES SCHOOL BUS

PUTTING SAFETY FIRST

- Standard electronic stability control
- Bendix® Intellipark® electronic parking brake standard
- No Student Left Behind® child monitor system
- Single-panel glass on entrance door for improved driver visibility
- IC Bus® Full View Camera Technology™ by Rosco® (optional)
- Entrance Door Alerts integrated into Dash Cluster; providing door ajar alerts if vehicle in motion & door is not properly closed

DRIVERFIRST™ ENVIRONMENT

- Standard 'wing' style instrument panel, angled toward driver
- State of the Art digital instrument cluster, including visibility to state-of-charge, estimated range and more!
- Standard Driver HVAC system with adjustable controls for driver comfort
- Standard stalk shifter for transmission control; optional push button shifter
- Steering wheel switches/controls are integrated, backlit, and color-coded
- USB-A and USB-C charging ports standard
- Driver cup holder
- LED interior dome & stepwell lights, available dimmer option

DURABILITY & SERVICEABILITY

- Meets or exceeds FMVSS/CMVSS
- 16-gauge steel, 90G/90G galvanized coating on steel body for enhanced corrosion resistance
- 14 gauge steel threaded body bows with continuous runners connecting all roof bows for superior strength
- Spot-welded body construction & framer assembled front end
- Optional Naviflex coating available on the bumpers — for optimal corrosion resistance
- Improved accessibility to routine maintenance items
- 'Hood assist' dual spring struts – wide opening for serviceability

CONNECTIVITY FOR ON-TIME PERFORMANCE

- All vehicles include factory-installed telematics with 5-year connectivity subscription
- OnCommand® Connection
  - 24/7 diagnostics and predictive maintenance tools
  - Real-time tracking and monitoring
- IC Bus® 360
  - Seamless communications with dealers and up-to-date repair status
  - Complete VIN-based information with specs, complete parts catalog, remote health data, and more
  - Online service request initiation and estimate approvals
  - Complete service history, up-to-date campaign information, and engine calibration status

---

- **GVWR**
  - Up to 35,000 lbs.
- **Capacity**
  - Up to 78 passengers
- **Wheelbase Options**
  - 217", 254", 276" or 289"
- **Single Rear Axle (4x2)**
  - Dana Spicer: 21,000 or 23,000 lbs.
- **Front Axle**
  - Meritor: 10,000 or 12,000 lbs.
- **Frame**
  - Heat-treated alloy steel (120,000 PSI)
- **Front Suspension**
  - Parabolic taper leaf: 10,000 or 12,000 lbs.
- **Rear Suspension**
  - International® Ride Optimized Suspension (IROS) Air: 21,000 or 23,000 lbs.
- **12V Electrical System**
  - Enersys Odyssey 12V 2300 CCA
- **Brakes**
  - Air disc brakes with ESC and ABS
  - Optional hydraulic brakes
- **Direct Drive Motor**
  - 650-volt, 6-phase permanent magnet motor
- **Tires**
  - 254", 276" & 289" wheelbase: 11R22.5 front and rear
  - 217" wheelbase: 255/70R22.5 front and rear
- **Rear Axle Ratio**
  - 5.57 or 6.83
- **Regenerative Braking**
  - Driver selectable, three levels
- **Peak Power**
  - 255 kW or 342 hp
- **Powertrain Batteries and Range Options**
  - 210 kWh (135 miles)
  - 315 kWh (200+ miles)
- **Charge Port**
  - Front standard or optional rear location
- **Charging**
  - Standard AC and DCFC charging ready
- **Fuel-Fired Heater**
  - Optional, left side
- **Kajeet SmartBus™ wifi available**
- **V2G Capability available**

www.ICBus.com

Note: The information and conclusions contained herein are believed to be correct at time of publication, but do not necessarily apply to similar vehicles with different specifications or with production dates after the production of this publication. Vehicles with different specifications or later dates of production may yield different results. Vehicle specifications are subject to change without notice. BAD 21001 01/2024

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Thomas BUILT BUSES

POWERING THE FUTURE


SCHOOL BUS
Thomas
STOP

Partners in possibility.

Thomas Built Buses has been moving the industry forward for more than 100 years. Now we're driving it in a whole new way with the Saf-T-Liner® C2 Jouley® electric bus.

Jouley has everything customers love about the Saf-T-Liner C2 bus. Industry-leading visibility. Low instrument panel. A-pillar windows. A driver-friendly environment. With Proterra's proven battery and drivetrain technologies, we're taking that legacy of excellence further.

Welcome to zero emissions. Welcome to sustainable solutions. Welcome to the new frontier of possibility.

BUILDING TOMORROW.

Great things happen when greatness comes together. Jouley is designed and manufactured in High Point, North Carolina by Thomas Built Buses, the leading school bus manufacturer in North America. Jouley rides on a chassis manufactured by the renowned Freightliner Custom Chassis Corporation (FCCC) in Gaffney, South Carolina. Jouley is powered by a battery and electric drivetrain from Proterra. Together these teams deliver manufacturing expertise, production efficiencies and unparalleled quality. Translation: everything you're looking for.

Designed by an engineering team with deep automotive expertise in ground-up EV design and platform adaptation, Proterra batteries check all the boxes:

SAFE

- Designed specifically for safe operation in heavy-duty transportation
- Enclosed in ballistic-grade materials that can withstand the toughest conditions
- Rigorously tested and third-party validated

SMART

- Liquid-cooled to ensure optimal operation in any climate
- Continuously monitored by multiple sensors
- Dynamically adjust over time for maximum performance

EFFICIENT

- Highest efficiency for maximum range
- Compact design for industry-leading energy density
- DC charging yields a full charge in approximately two to three hours depending on dispenser capabilites

PROVEN

- Record-breaking range for heavy-duty vehicles
- Efficient, smart, safe drivetrain technology for optimal performance in any climate

Zero emissions. Endless possibilities.

When it comes to transportation, green is in—and for good reason. Electric vehicles offer zero tailpipe emissions, lower operating costs, easier maintenance, a quieter ride and more. These benefits have inspired widespread industry adoption, with more cities moving toward battery-electric transit. And barriers for implementation have fallen by the wayside as battery range increases, prices decrease and funding opportunities roll in.

With Jouley, school districts can count on:

- **SAVING MONEY** – Fuel costs are lower because electricity costs are more stable.
- **BETTER PERFORMANCE** – Electric motors have fewer moving parts, no liquid fuels, and no engine oil changes, making maintenance simpler and less expensive.
- **ZERO EMISSIONS AT THE TAILPIPE** – 100% battery-electric reduces the emission of harmful gases into the atmosphere, reduces exposure to emissions, improves air quality, and offers health benefits for students and the community.
- **QUIETER RIDE** – No engine means no rattling or loud noises from under the hood, allowing drivers to focus and reducing noise pollution in your community.
- **MAXIMUM RANGE** – Regenerative power modes add kinetic energy back to the battery when the bus decelerates to enhance range. And with low daily mileage, predictable, planned routes and midday downtime, you don't have to worry about vehicle range.
- **PROVEN PERFORMANCE** – Proterra drivetrains deliver unparalleled performance and greater fuel economy.
- **V2G CAPABILITIES** – Jouley has the potential to be used as a stationary energy storage system, with applications such as charging during off-peak hours and putting energy back on the grid during peak hours when needed by utilities.


Thomas
BUILT BUSES
Thomas
BUILT BUSES



Helping you navigate the path to EV implementation.

The route to EVs is complex, especially when it comes to infrastructure.

The good news: Thomas Built Buses is the Electric Bus Authority. Our team of EV specialists has the experience, expertise and partnerships to help you navigate the route to electric bus implementation.

With the Jouley electric school bus, best charging strategy, turn-key infrastructure installation and our expertise, we provide a comprehensive solution to electrify your school bus fleet. Our consulting team has experienced engineering and project management experts who work with schools to design and implement the best infrastructure installation for their depot, managing the whole process from start to finish and providing a scalable, ready-to-roll solution.

Ready? Let's go.

VEHICLE SPECIFICATIONS

TOTAL ENERGY (kWh)	246
OPERATING EFFICIENCY*	kWh/mile - 1.474 MPGe – 24.6
RANGE*	Up to 150 – Operating range in miles (usable energy***/efficiency)
TOP SPEED	65
ACCELERATION	49
HORSEPOWER	295 peak, 170 continuous
MOTOR	Proterra ProDrive drivetrain; single permanent magnet drive motor
TRANSMISSION GEARBOX	Proterra 2-speed auto shift EV gearbox
BATTERY THERMAL MANAGEMENT SYSTEM	Liquid cooled
BATTERY PACK ENCLOSURE	Ruggedized 10mm thick aluminum
BRAKING SYSTEM	2 regenerative power modes; air brakes
STARTABILITY	19% grade

CHARGING SPECIFICATIONS

TYPE	Plug-in, DC fast charging
STANDARD	J1772 CCS Type 1
CHARGE POWER	Up to 90 kW
CHARGING TIME (EMPTY TO FULL)	Approximately 3 hours with 60 kW charger. Approximately 2 hours with 90 kW charger

WARRANTY

BATTERY CAPACITY	8 years / 175,000 miles / 200,000 kWh of gross discharge throughout per pack
BATTERY MATERIALS & WORKMANSHIP	8 years / 175,000 miles
DRIVETRAIN	5 years / 100,000 miles

* will vary with route conditions, weather, vehicle configuration and driver behavior.

**vehicle efficiency estimate

***all vehicle batteries must be limited to usable capacity to decrease degradation and optimize longevity.

To start your electric school bus journey,
visit ThomasBuiltBuses.com/Electric. We'll be with you, every mile of the way.





Daimler Truck Financial

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Type A Route Analysis

G5 (175 kWh)

							AM Route								PM Route								Daily Route			
Bus #	Usable Battery Capacity (kWh)	Battery Efficiency in Average Weather (kWh/mile)	Battery Efficiency in Average Weather & Hilly Conditions (kWh/mile)	Battery Efficiency in Cold Weather (kWh/mile)	Battery Efficiency in Cold Weather & Hilly Conditions (kWh/mile)	Assumed Flat Road %	AM Route Length (mi)	Assumed Distance on Flat Roads (mi)	Assumed Distance Up & Down Hills (mi)	Energy Consumption in Average Weather (kWh)	Energy Consumption in Cold Weather (kWh)	End of Route Remaining Battery in Average Weather (kWh)	End of Route SOC in Average Weather (%)	End of Route Remaining Battery in Cold Weather (kWh)	End of Route SOC in Cold Weather (%)	PM Route Length (mi)	Assumed Distance on Flat Roads (mi)	Assumed Distance Up & Down Hills	Energy Consumption in Average Weather (kWh)	Energy Consumption in Cold Weather (kWh)	End of Route Remaining Battery in Average Weather (kWh)	End of Route SOC in Average Weather (%)	End of Route Remaining Battery in Cold Weather (kWh)	End of Route SOC in Cold Weather (%)	Daily Route Mileage (mi)	Daily Energy Consumption in Average Weather (kWh)	Daily Energy Consumption in Cold Weather (kWh)	Meets Route without Needing Midday Charge?
263	156	0.88	1.58	1.25	2.26	60%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0.00	0.00	0.00	Yes
285	156	0.88	1.58	1.25	2.26	60%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0.00	0.00	0.00	Yes
286	156	0.88	1.58	1.25	2.26	60%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0.00	0.00	0.00	Yes
315	156	0.88	1.58	1.25	2.26	60%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	79	47.4	31.6	91.40	130.57	64.35	41%	25.18	16%	79.00	91.40	130.57	No
316	156	0.88	1.58	1.25	2.26	60%	39	23.4	15.6	45.12	64.46	110.63	71%	91.29	59%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	39.00	45.12	64.46	Yes
317	156	0.88	1.58	1.25	2.26	60%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0.00	0.00	0.00	Yes
321	156	0.88	1.58	1.25	2.26	60%	106	63.6	42.4	122.63	175.19	33.12	21%	-19.44	-12%	78	46.8	31.2	90.24	128.91	65.51	42%	26.84	17%	184.00	212.87	304.10	No
322	156	0.88	1.58	1.25	2.26	60%	45	27	18	52.06	74.37	103.69	67%	81.38	52%	43	25.8	17.2	49.75	71.07	106.00	68%	84.68	54%	88.00	101.81	145.44	No
323	156	0.88	1.58	1.25	2.26	60%	52	31.2	20.8	60.16	85.94	95.59	61%	69.81	45%	48	28.8	19.2	55.53	79.33	100.22	64%	76.42	49%	100.00	115.69	165.27	No
324	156	0.88	1.58	1.25	2.26	60%	45	27	18	52.06	74.37	103.69	67%	81.38	52%	32	19.2	12.8	37.02	52.89	118.73	76%	102.86	66%	77.00	89.08	127.26	No
325	156	0.88	1.58	1.25	2.26	60%	71	42.6	28.4	82.14	117.34	73.61	47%	38.41	25%	86	51.6	34.4	99.50	142.14	56.25	36%	13.61	9%	157.00	181.64	259.48	No
326	156	0.88	1.58	1.25	2.26	60%	86	51.6	34.4	90.50	142.14	56.25	36%	11.61	7%	75	45	30	86.77	123.96	68.98	44%	31.79	20%	161.00	186.26	260.09	No
327	156	0.88	1.58	1.25	2.26	60%	23	13.8	9.2	26.61	38.01	129.14	83%	117.74	76%	25	15	10	28.92	41.32	126.83	81%	114.43	73%	48.00	55.53	79.33	Yes
332	156	0.88	1.58	1.25	2.26	60%	45	27	18	52.06	74.37	103.69	67%	81.38	52%	94	56.4	37.6	108.75	155.36	47.00	30%	0.39	0%	139.00	160.81	229.73	No
333	156	0.88	1.58	1.25	2.26	60%	63	37.8	25.2	72.89	104.12	82.86	53%	51.63	33%	64	38.4	25.6	74.04	105.78	81.71	52%	49.97	32%	127.00	146.93	209.90	No
334	156	0.88	1.58	1.25	2.26	60%	84	50.4	33.6	97.18	138.83	58.57	38%	16.92	11%	82	49.2	32.8	94.87	135.52	60.88	39%	20.23	13%	166.00	192.05	274.35	No
336	156	0.88	1.58	1.25	2.26	60%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0.00	0.00	0.00	Yes
337	156	0.88	1.58	1.25	2.26	60%	75	45	30	86.77	123.96	68.98	44%	31.79	20%	66	39.6	26.4	76.36	109.08	79.39	51%	46.67	30%	141.00	163.13	233.04	No
344	156	0.88	1.58	1.25	2.26	60%	47	28.2	18.8	54.38	77.68	101.17	65%	78.07	50%	75	42	28	86.98	115.69	74.77	48%	40.06	26%	117.00	141.36	193.77	No
345	156	0.88	1.58	1.25	2.26	60%	69	41.4	27.6	79.83	114.04	75.92	49%	41.71	27%	47	28.2	18.8	54.38	77.68	101.37	65%	76.07	50%	116.00	134.20	191.72	No
347	156	0.88	1.58	1.25	2.26	60%	22	13.2	8.8	25.45	36.36	130.30	84%	119.39	77%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	22.00	25.45	36.36	Yes
352	156	0.88	1.58	1.25	2.26	60%	52	31.2	20.8	60.16	85.94	95.59	61%	69.81	45%	51	30.6	20.4	59.00	84.20	96.75	62%	71.46	46%	103.00	119.16	170.23	No
353	156	0.88	1.58	1.25	2.26	60%	45	27	18	52.06	74.37	103.69	67%	81.38	52%	115	69	46	133.05	190.07	22.70	15%	34.32	22%	160.00	185.11	264.44	No
354	156	0.88	1.58	1.25	2.26	60%	66	39.6	26.4	76.36	109.08	79.39	51%	46.67	30%	81	48.6	32.4	93.71	133.87	62.04	40%	21.88	14%	147.00	170.07	242.95	No
355	156	0.88	1.58	1.25	2.26	60%	47	28.2	18.8	54.38	77.68	101.17	65%	78.07	50%	65	39	26	75.20	107.43	80.55	52%	48.32	31%	112.00	129.57	185.11	No
363	156	0.88	1.58	1.25	2.26	60%	109	65.4	43.6	126.10	180.15	29.65	19%	-24.40	-16%	58	34.8	23.2	67.10	95.86	88.65	57%	59.89	38%	167.00	193.21	276.01	No
368	156	0.88	1.58	1.25	2.26	60%	32	19.2	12.8	37.02	52.89	118.73	76%	102.86	66%	56	33.6	22.4	64.79	92.55	90.96	58%	63.20	41%	88.00	101.81	145.44	No
369	156	0.88	1.58	1.25	2.26	60%	28	16.8	11.2	32.39	46.28	123.36	79%	106.47	70%	44	26.4	17.6	50.90	72.72	104.85	67%	83.03	53%	72.00	83.30	119.00	Yes
370	156	0.88	1.58	1.25	2.26	60%	75	45	30	86.77	123.96	68.98	44%	31.79	20%	85	51	34	98.34	140.48	57.41	37%	15.27	10%	160.00	185.11	264.44	No
371	156	0.88	1.58	1.25	2.26	60%	78	46.8	31.2	90.24	128.91	65.51	42%	26.84	17%	75	45	30	86.77	123.96	68.98	44%	31.79	20%	153.00	177.01	252.87	No
372	156	0.88	1.58	1.25	2.26	60%	41	24.6	16.4	47.43	67.76	108.32	70%	87.99	56%	55	33	22	63.60	90.90	92.12	59%	64.85	42%	96.00	111.06	158.66	No
373	156	0.88	1.58	1.25	2.26	60%	92	55.2	36.8	106.46	152.05	49.31	32%	3.70	2%	97	58.2	38.8	112.22	160.32	43.53	28%	-4.57	-3%	189.00	218.66	312.37	No
374	156	0.88	1.58	1.25	2.26	60%	59	35.4	23.6	68.26	97.51	87.49	56%	58.24	37%	30	18	12	34.71	49.58	121.04	78%	106.17	68%	89.00	102.97	147.09	No
375	156	0.88	1.58	1.25	2.26	60%	50	30	20	57.85	82.64	97.90	63%	73.11	47%	25	15	10	28.92	41.32	126.83	81%	114.43	73%	75.00	86.77	123.96	Yes
380	156	0.88	1.58	1.25	2.26	60%	53	31.8	21.2	61.32	87.60	94.43	61%	68.15	44%	46	27.6	18.4	53.22	76.03	102.53	66%	79.72	51%	99.00	114.53	163.62	No
390	156	0.88	1.58	1.25	2.26	60%	45	27	18	52.06	74.37	103.69	67%	81.38	52%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	45.00	52.06	74.37	Yes
391	156	0.88	1.58	1.25	2.26	60%	109	65.4	43.6	126.10	180.15	29.65	19%	-24.40	-16%	69	41.4	27.6	79.88	114.04	75.92	49%	41.71	27%	178.00	205.93	294.19	No
392	156	0.88	1.58	1.25	2.26	60%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0	0	0	0.00	0.00	155.75	100%	155.75	100%	0.00	0.00	0.00	Yes
393	156	0.88	1.58	1.25	2.26	60%	47	28.2	18.8	54.38	77.68	101.17	65%	78.07	50%	68	40.8	27.2	78.67	112.39	77.08	49%	43.36	28%	115.00	133.05	190.07	No

Type A Route Analysis

Z-600 (131 kWh)

							AM Route									PM Route											Daily Route			
Bus #	Usable Battery Capacity	Battery Efficiency in Average Weather (kWh/mile)	Battery Efficiency in Average Weather & Hilly Conditions (kWh/mile)	Battery Efficiency in Cold Weather (kWh/mile)	Battery Efficiency in Cold Weather & Hilly Conditions (kWh/mile)	Assumed Flat Road %	AM Route Length (mi)	Assumed Distance on Flat Roads (mi)	Assumed Distance Up & Down Hills (mi)	Energy Consumption in Average Weather (kWh)	Energy Consumption in Cold Weather (kWh)	End of Route Remaining Battery in Average Weather (kWh)	End of Route SOC in Average Weather (%)	End of Route Remaining Battery in Cold Weather (kWh)	End of Route SOC in Cold Weather (%)	PM Route Length (mi)	Assumed Distance on Flat Roads (mi)	Assumed Distance Up & Down Hills (mi)	Energy Consumption in Average Weather (kWh)	Energy Consumption in Cold Weather (kWh)	End of Route Remaining Battery in Average Weather (kWh)	End of Route SOC in Average Weather (%)	End of Route Remaining Battery in Cold Weather (kWh)	End of Route SOC in Cold Weather (%)	Daily Route Mileage (mi)	Daily Energy Consumption in Average Weather (kWh)	Daily Energy Consumption in Cold Weather (kWh)	Meets Route without Needing Midday Charge?
263	116.59	0.79	1.50	1.13	2.14	60%	0	0	0	0.00	0.00	116.59	100%	116.59	100%	0	0.00	0.00	0.00	0.00	116.59	100%	116.59	100%	0.00	0.00	0.00	Yes
285	116.59	0.79	1.50	1.13	2.14	60%	0	0	0	0.00	0.00	116.59	100%	116.59	100%	0	0.00	0.00	0.00	0.00	116.59	100%	116.59	100%	0.00	0.00	0.00	Yes
286	116.59	0.79	1.50	1.13	2.14	60%	0	0	0	0.00	0.00	116.59	100%	116.59	100%	0	0.00	0.00	0.00	0.00	116.59	100%	116.59	100%	0.00	0.00	0.00	Yes
315	116.59	0.79	1.50	1.13	2.14	60%	0	0	0	0.00	0.00	116.59	100%	116.59	100%	79	67.40	31.60	84.99	121.42	31.60	27%	-4.83	-4%	79.00	84.99	121.42	No
316	116.59	0.79	1.50	1.13	2.14	60%	39	23.4	15.6	41.96	59.94	74.63	64%	56.65	49%	0	0.00	0.00	0.00	0.00	116.59	100%	116.59	100%	39.00	41.96	59.94	Yes
317	116.59	0.79	1.50	1.13	2.14	60%	0	0	0	0.00	0.00	116.59	100%	116.59	100%	0	0.00	0.00	0.00	0.00	116.59	100%	116.59	100%	0.00	0.00	0.00	Yes
321	116.59	0.79	1.50	1.13	2.14	60%	106	63.6	42.4	114.04	162.50	2.55	2%	-46.33	-40%	78	46.80	31.20	83.92	119.88	32.67	28%	-1.29	-1%	184.00	197.96	282.80	No
322	116.59	0.79	1.50	1.13	2.14	60%	45	27	18	48.41	69.16	68.18	58%	47.43	41%	43	25.80	17.20	46.26	66.09	70.33	60%	50.50	43%	88.00	94.68	135.25	No
323	116.59	0.79	1.50	1.13	2.14	60%	52	31.2	20.8	55.94	79.92	60.65	52%	34.67	31%	48	28.80	19.20	51.64	73.77	64.95	56%	42.82	37%	100.00	107.59	153.69	No
324	116.59	0.79	1.50	1.13	2.14	60%	45	27	18	48.41	69.16	68.18	58%	47.43	41%	32	19.20	12.80	34.43	49.18	82.16	70%	67.41	58%	77.00	82.84	118.36	No
325	116.59	0.79	1.50	1.13	2.14	60%	71	42.6	28.4	76.39	109.12	40.20	34%	7.47	6%	86	51.60	34.40	92.52	132.18	24.07	21%	-15.59	-13%	157.00	168.91	241.30	No
326	116.59	0.79	1.50	1.13	2.14	60%	86	51.6	34.4	92.52	132.18	24.07	21%	-15.59	-13%	75	45.00	30.00	80.69	115.27	35.90	31%	1.32	1%	161.00	173.21	247.45	No
327	116.59	0.79	1.50	1.13	2.14	60%	23	13.8	9.2	24.74	35.35	91.85	79%	81.24	70%	25	15.00	10.00	26.90	38.42	89.69	77%	78.17	67%	48.00	51.64	73.77	Yes
332	116.59	0.79	1.50	1.13	2.14	60%	45	27	18	48.41	69.16	68.18	58%	47.43	41%	94	56.40	37.60	101.13	144.47	15.46	13%	-27.88	-24%	139.00	149.54	213.63	No
333	116.59	0.79	1.50	1.13	2.14	60%	63	37.8	25.2	67.78	96.83	48.81	42%	19.76	17%	64	38.40	25.60	68.85	98.36	47.74	41%	18.23	16%	127.00	136.63	195.19	No
334	116.59	0.79	1.50	1.13	2.14	60%	84	50.4	33.6	90.27	128.10	26.22	22%	-12.51	-11%	82	49.20	32.80	88.12	126.03	28.37	24%	-9.44	-8%	166.00	178.59	255.13	No
336	116.59	0.79	1.50	1.13	2.14	60%	0	0	0	0.00	0.00	116.59	100%	116.59	100%	0	0.00	0.00	0.00	0.00	116.59	100%	116.59	100%	0.00	0.00	0.00	Yes
337	116.59	0.79	1.50	1.13	2.14	60%	75	45	30	80.69	115.27	35.90	31%	1.32	1%	66	39.60	26.40	71.01	101.44	41.58	36%	15.15	13%	141.00	151.70	216.71	No
344	116.59	0.79	1.50	1.13	2.14	60%	47	28.2	18.8	50.57	72.24	66.02	57%	44.35	38%	29	17.40	11.60	31.20	44.58	72.03	62%	49.36	42%	76.00	81.81	116.82	No
345	116.59	0.79	1.50	1.13	2.14	60%	69	41.4	27.6	74.23	106.05	42.36	36%	10.54	9%	47	28.20	18.80	50.57	72.24	66.02	57%	44.35	38%	116.00	124.80	178.29	No
347	116.59	0.79	1.50	1.13	2.14	60%	22	13.2	8.8	23.67	33.81	92.92	80%	82.78	71%	0	0.00	0.00	0.00	0.00	116.59	100%	116.59	100%	22.00	23.67	33.81	Yes
352	116.59	0.79	1.50	1.13	2.14	60%	52	31.2	20.8	55.94	79.92	60.65	52%	34.67	31%	51	30.60	20.40	54.87	78.38	61.72	53%	38.21	33%	103.00	110.81	158.30	No
353	116.59	0.79	1.50	1.13	2.14	60%	45	27	18	48.41	69.16	68.18	58%	47.43	41%	115	69.00	46.00	123.72	176.75	-7.13	-6%	-60.16	-52%	160.00	172.14	246.91	No
354	116.59	0.79	1.50	1.13	2.14	60%	66	39.6	26.4	71.01	101.44	45.58	39%	15.15	13%	81	48.60	32.40	87.14	124.49	29.45	25%	-7.90	-7%	147.00	158.15	225.93	No
355	116.59	0.79	1.50	1.13	2.14	60%	47	28.2	18.8	50.57	72.24	66.02	57%	44.35	38%	65	39.00	26.00	69.93	99.90	46.66	40%	16.69	14%	112.00	120.50	172.14	No
363	116.59	0.79	1.50	1.13	2.14	60%	109	65.4	43.6	117.27	167.53	-0.68	-1%	-50.94	-44%	58	34.80	23.20	62.40	89.14	54.19	46%	27.45	24%	167.00	179.67	256.67	No
368	116.59	0.79	1.50	1.13	2.14	60%	32	19.2	12.8	34.43	49.18	82.16	70%	67.41	58%	56	33.60	22.40	60.25	86.07	56.34	48%	30.52	26%	88.00	94.68	135.25	No
369	116.59	0.79	1.50	1.13	2.14	60%	28	16.8	11.2	30.12	43.03	86.47	74%	73.56	63%	44	26.40	17.60	47.34	67.63	69.25	59%	48.96	42%	72.00	77.46	110.66	No
370	116.59	0.79	1.50	1.13	2.14	60%	75	45	30	80.69	115.27	35.90	31%	1.32	1%	85	51.00	34.00	91.45	130.64	25.14	22%	-14.05	-12%	160.00	172.14	246.91	No
371	116.59	0.79	1.50	1.13	2.14	60%	78	46.8	31.2	83.92	119.88	32.67	28%	-2.29	-2%	75	45.00	30.00	80.69	115.27	31.90	27%	1.32	1%	153.00	164.61	235.15	No
372	116.59	0.79	1.50	1.13	2.14	60%	41	24.6	16.4	44.11	63.01	72.68	62%	53.58	46%	55	33.00	22.00	59.17	84.53	57.42	49%	32.06	27%	96.00	103.28	147.55	No
373	116.59	0.79	1.50	1.13	2.14	60%	92	55.2	36.8	98.98	141.40	17.61	15%	-24.81	-21%	97	58.20	38.80	104.36	149.08	12.23	10%	-32.49	-28%	189.00	203.34	290.48	No
374	116.59	0.79	1.50	1.13	2.14	60%	59	35.4	23.6	63.48	90.68	53.11	46%	25.91	22%	30	18.00	12.00	32.28	46.11	84.31	72%	70.48	60%	89.00	95.75	136.79	No
385	116.59	0.79	1.50	1.13	2.14	60%	50	30	20	53.79	76.85	62.80	54%	39.74	34%	25	15.00	10.00	26.90	38.42	89.69	77%	78.17	67%	75.00	80.69	115.27	No
389	116.59	0.79	1.50	1.13	2.14	60%	53	31.8	21.2	57.02	81.46	59.57	51%	35.13	30%	46	27.60	18.40	49.48	70.70	67.10	58%	45.89	39%	99.00	106.51	152.16	No
390	116.59	0.79	1.50	1.13	2.14	60%	45	27	18	48.41	69.16	68.18	58%	47.43	41%	0	0.00	0.00	0.00	0.00	116.59	100%	116.59	100%	45.00	48.41	69.16	Yes
391	116.59	0.79	1.50	1.13	2.14	60%	109	65.4	43.6	117.27	167.53	-0.68	-1%	-50.94	-44%	69	41.40	27.60	74.23	106.05	42.36	36%	10.54	9%	178.00	191.50	273.58	No
392	116.59	0.79	1.50	1.13	2.14	60%	0	0	0	0.00	0.00	116.59	100%	116.59	100%	0	0.00	0.00	0.00	0.00	116.59	100%	116.59	100%	0.00	0.00	0.00	Yes
393	116.59	0.79	1.50	1.13	2.14	60%	47	28.2	18.8	50.57	72.24	66.02	57%	44.35	38%	68	40.80	27.20	73.16	104.51	43.43	37%	12.08	10%	115.00	123.72	176.75	No

Type C Route Analysis

CE Series 474.9" OAL (315 kWh)

												AM Route						PM Route											Daily Route			
Bus #	Usable Battery Capacity (kWh)	Battery Efficiency in Average Weather (kWh/mile)	Battery Efficiency in Average Weather & Hilly Conditions (kWh/mile)	Battery Efficiency in Cold Weather (kWh/mile)	Battery Efficiency in Cold Weather & Hilly Conditions (kWh/mile)	Assumed Rist Road %	AM Route Length (mi)	Assumed Distance on Flat (kmile)	Assumed Distance Up & Down Hills	Energy Consumption in Average Weather (kWh)	Energy Consumption in Cold Weather (kWh)	End of Route Remaining Battery in Average Weather (kWh)	End of Route SOC in Average Weather (%)	End of Route Remaining Battery in Cold Weather (kWh)	End of Route SOC in Cold Weather (%)	PM Route Length (mi)	Assumed Distance on Flat Roads (mi)	Assumed Distance Up & Down Hills	Energy Consumption in Average Weather (kWh)	Energy Consumption in Cold Weather (kWh)	End of Route Remaining Battery in Average Weather (kWh)	End of Route SOC in Average Weather (%)	End of Route Remaining Battery in Cold Weather (kWh)	End of Route SOC in Cold Weather (%)	Daily Route Mileage (mi)	Daily Energy Consumption in Average Weather (kWh)	Daily Energy Consumption in Cold Weather (kWh)	Meets Route without Needing Midday Charge?
287	284	1.58	3.28	2.25	4.68	60%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	0.00	0.00	0.00	Yes			
301	284	1.58	3.28	2.25	4.68	60%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	32	19.2	12.8	37.02	103.11	246.48	87%	180.39	64%	32.00	37.02	103.11	Yes			
302	284	1.58	3.28	2.25	4.68	60%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	19	11.4	7.6	21.98	61.22	261.52	92%	222.28	78%	19.00	21.98	61.22	Yes			
303	284	1.58	3.28	2.25	4.68	60%	28	16.8	11.2	63.15	90.22	220.35	78%	193.28	68%	35	21	14	40.49	112.77	243.01	86%	170.73	60%	63.00	103.65	202.99	Yes			
304	284	1.58	3.28	2.25	4.68	60%	62	37.2	24.8	139.84	199.77	143.66	51%	83.73	30%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	62.00	139.84	199.77	Yes			
309	284	1.58	3.28	2.25	4.68	60%	35	21	14	78.94	112.77	204.56	72%	170.73	60%	20	12	8	23.16	64.44	260.36	92%	219.06	77%	55.00	102.08	177.22	Yes			
310	284	1.58	3.28	2.25	4.68	60%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	112	67.2	44.8	129.17	360.88	153.93	54%	-77.38	0%	112.00	129.17	360.88	No			
311	284	1.58	3.28	2.25	4.68	60%	35	21	14	78.94	112.77	204.56	72%	170.73	60%	24	14.4	9.6	27.77	77.33	255.73	90%	206.17	73%	59.00	106.71	190.11	Yes			
312	284	1.58	3.28	2.25	4.68	60%	36	21.6	14.4	81.20	116.00	202.30	71%	167.50	59%	11	6.6	4.4	12.73	35.44	270.77	96%	248.06	87%	47.00	93.92	151.44	Yes			
318	284	1.58	3.28	2.25	4.68	60%	36	21.6	14.4	81.20	116.00	202.30	71%	167.50	59%	33	19.8	13.2	38.18	106.33	245.32	87%	177.17	62%	69.00	119.38	223.33	No			
319	284	1.58	3.28	2.25	4.68	60%	36	21.6	14.4	81.20	116.00	202.30	71%	167.50	59%	36	21.6	14.4	41.65	116.00	241.85	85%	167.50	59%	72.00	122.85	231.99	No			
330	284	1.58	3.28	2.25	4.68	60%	32	19.2	12.8	72.18	103.11	211.32	75%	180.39	64%	31	18.6	12.4	35.86	99.89	247.64	87%	183.61	65%	63.00	108.04	202.99	Yes			
331	284	1.58	3.28	2.25	4.68	60%	22	13.2	8.8	49.62	70.89	233.88	82%	212.61	75%	33	19.8	13.2	38.18	106.33	245.32	87%	177.17	62%	55.00	87.80	177.22	Yes			
340	284	1.58	3.28	2.25	4.68	60%	17	10.2	6.8	38.34	54.78	245.16	86%	228.72	81%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	17.00	38.34	54.78	Yes			
341	284	1.58	3.28	2.25	4.68	60%	30	18	12	67.66	96.66	215.84	76%	186.84	66%	20	12	8	23.16	64.44	260.36	92%	219.06	77%	50.00	90.80	161.11	Yes			
342	284	1.58	3.28	2.25	4.68	60%	32	19.2	12.8	74.43	106.33	209.07	74%	177.17	62%	32	19.2	12.8	37.02	103.11	246.48	87%	180.39	64%	64.00	111.45	209.44	Yes			
343	284	1.58	3.28	2.25	4.68	60%	31	18.6	12.4	69.92	99.89	213.58	75%	183.61	65%	45	27	18	52.06	145.00	231.44	82%	138.50	49%	76.00	121.98	244.88	No			
346	284	1.58	3.28	2.25	4.68	60%	39	23.4	15.6	87.96	125.46	195.54	69%	157.84	56%	34	20.4	13.6	39.34	109.55	244.16	86%	173.95	61%	73.00	127.30	235.22	No			
348	284	1.58	3.28	2.25	4.68	60%	38	22.8	15.2	85.71	122.44	197.79	70%	161.06	57%	34	20.4	13.6	39.34	109.55	244.16	86%	173.95	61%	72.00	125.04	231.99	No			
349	284	1.58	3.28	2.25	4.68	60%	23	13.8	9.2	51.88	74.11	231.62	82%	209.39	74%	26	15.6	10.4	30.08	83.78	253.42	89%	199.72	70%	49.00	81.96	157.88	Yes			
350	284	1.58	3.28	2.25	4.68	60%	21	12.6	8.4	47.37	67.66	236.13	83%	215.84	76%	35	21	14	40.49	112.77	243.01	86%	170.73	60%	56.00	87.86	180.44	Yes			
371	284	1.58	3.28	2.25	4.68	60%	30	18	12	67.66	96.66	215.84	76%	186.84	66%	25	15	10	28.92	80.55	254.58	90%	202.95	72%	55.00	96.59	177.22	Yes			
372	284	1.58	3.28	2.25	4.68	60%	58	34.8	23.2	130.82	186.88	152.68	54%	96.62	34%	34	20.4	13.6	39.34	109.55	244.16	86%	173.95	61%	92.00	170.15	286.44	No			
373	284	1.58	3.28	2.25	4.68	60%	22	13.2	8.8	49.62	70.89	233.88	82%	212.61	75%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	22.00	49.62	70.89	Yes			
374	284	1.58	3.28	2.25	4.68	60%	25	15	10	56.39	80.55	227.11	80%	202.95	72%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	25.00	56.39	80.55	Yes			
359	284	1.58	3.28	2.25	4.68	60%	24	14.4	9.6	54.13	77.33	229.37	81%	206.17	73%	20	12	8	23.16	64.44	260.36	92%	219.06	77%	44.00	77.27	141.77	Yes			
360	284	1.58	3.28	2.25	4.68	60%	27	16.2	10.8	60.90	87.00	222.60	79%	196.50	69%	23	13.8	9.2	26.61	74.11	256.89	91%	209.39	74%	50.00	87.51	161.11	Yes			
361	284	1.58	3.28	2.25	4.68	60%	29	17.4	11.6	65.41	93.44	218.09	77%	190.06	67%	25	15	10	28.92	80.55	254.58	90%	202.95	72%	54.00	94.33	174.00	Yes			
362	284	1.58	3.28	2.25	4.68	60%	47	28.2	18.8	106.01	151.44	177.49	63%	122.06	47%	25	15	10	28.92	80.55	254.58	90%	202.95	72%	72.00	134.93	231.99	No			
364	284	1.58	3.28	2.25	4.68	60%	28	16.8	11.2	63.15	90.22	220.35	78%	193.28	68%	24	14.4	9.6	27.77	77.33	255.73	90%	206.17	73%	52.00	90.92	167.55	Yes			
365	284	1.58	3.28	2.25	4.68	60%	18	10.8	7.2	40.60	58.00	242.90	86%	225.50	80%	41	24.6	16.4	47.43	132.11	236.07	83%	151.39	53%	59.00	88.03	190.11	Yes			
366	284	1.58	3.28	2.25	4.68	60%	32	19.2	12.8	72.18	103.11	211.32	75%	180.39	64%	21	12.6	8.4	24.30	67.66	259.20	91%	215.84	76%	53.00	96.47	170.77	Yes			
367	284	1.58	3.28	2.25	4.68	60%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	0.00	0.00	0.00	Yes			
375	284	1.58	3.28	2.25	4.68	60%	24	14.4	9.6	54.13	77.33	229.37	81%	206.17	73%	34	20.4	13.6	39.34	109.55	244.16	86%	173.95	61%	58.00	93.47	184.88	Yes			
376	284	1.58	3.28	2.25	4.68	60%	31	18.6	12.4	69.92	99.89	213.58	75%	183.61	65%	24	14.4	9.6	27.77	77.33	255.73	90%	206.17	73%	55.00	97.69	177.22	Yes			
377	284	1.58	3.28	2.25	4.68	60%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	29	17.4	11.6	33.55	93.44	249.95	88%	190.06	67%	29.00	33.55	93.44	Yes			
378	284	1.58	3.28	2.25	4.68	60%	7	4.2	2.8	15.79	22.55	267.71	94%	260.95	92%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	7.00	15.79	22.55	Yes			
379	284	1.58	3.28	2.25	4.68	60%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	16	9.6	6.4	18.51	51.55	264.99	93%	231.95	82%	16.00	18.51	51.55	Yes			
380	284	1.58	3.28	2.25	4.68	60%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	0.00	0.00	0.00	Yes			
381	284	1.58	3.28	2.25	4.68	60%	31	18.6	12.4	69.92	99.89	213.58	75%	183.61	65%	32.7	20.22	13.48	38.99	108.59	244.51	86%	174.91	62%	64.70	108.91	208.47	Yes			
382	284	1.58	3.28	2.25	4.68	60%	29	17.4	11.6	65.41	93.44	218.09	77%	190.06	67%	33	19.8	13.2	38.18	106.33	245.32	87%	177.17	62%	62.00	103.59	199.77	Yes			
383	284	1.58	3.28	2.25	4.68	60%	31	18.6	12.4	69.92	99.89	213.58	75%	183.61	65%	32	19.2	12.8	37.02	103.11	246.48	87%	180.39	64%	63.00	106.94	202.99	Yes			
384	284	1.58	3.28	2.25	4.68	60%	35	21	14	78.94	112.77	204.56	72%	170.73	60%	58	34.8	23.2	67.10	186.88	216.40	76%	96.62	34%	93.00	146.04	299.66	No			
386	284	1.58	3.28	2.25	4.68	60%	26	15.6	10.4	58.64	83.78	224.86	79%	199.72	70%	19	11.4	7.6	21.98	61.22	261.52	92%	222.28	78%	45.00	80.62	145.00	Yes			
387	284	1.58	3.28	2.25	4.68	60%	15	9	6	33.83	48.33	249.67	88%	235.17	83%	105	63	42	121.48	338.22	162.02	57%	-54.82	0%	130.00	155.31	386.66	No			
388	284	1.58	3.28	2.25	4.68	60%	28	16.8	11.2	63.15	90.22	220.35	78%	193.28	68%	57	34.2	22.8	65.96	183.66	217.56	77%	99.84	35%	85.00	129.10	273.88	No			
344	284	1.58	3.28	2.25	4.68	60%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	28	16.8	11.2	32.39	90.22	251.11	89%	193.28	68%	28.00	32.39	90.22	Yes			
345	284	1.58	3.28	2.25	4.68	60%	25	15	10	56.39	80.55	227.11	80%	202.95	72%	93	55.8	37.2	107.59	299.66	175.91	62%	-16.16	0%	118.00	163.98	380.21	No			
346	284	1.58	3.28	2.25	4.68	60%	0	0	0	0.00	0.00	283.50	100%	283.50	100%	37	22.2	14.8	42.81	119.22	240.69	85%	164.28	58%	37.00	42.81	119.22	Yes			
347	284	1.58	3.28	2.25	4.68	60%	34	20.4	13.6	76.69	108.55	206.81	73%	173.95	61%	30	18	12	34.71	96.66	248.79	88%	186.84	66%	64.00	111.39	206.22	Yes			
398	284	1.58	3.28	2.25	4.68	60%	28	16.8	11.2	63.15	90.22	220.35	78%	193.28	68%	17	10.2	6.8	19.47	54.78	263.83	93%	228.72	81%	45.00	82.62	145.00	Yes			
399	284	1.58	3.28	2.25	4.68	60%	107	64.2	42.8	241.34	344.77	42.16	15%	-41.27	-15%	39	23.4	15.6	45.12	125.64	238.38	84%	157.84	56%	146.00	286.46	470.43	No			

Type C Route Analysis

Saf-T-Liner C2 Electric "Jouley"

							AM Route								PM Route									Daily Route			
Run #	Usable Battery Capacity	Battery Efficiency in Average Weather (kWh/mile)	Battery Efficiency in Average Weather & Hilly Conditions (kWh/mile)	Battery Efficiency in Cold Weather (kWh/mile)	Battery Efficiency in Cold Weather & Hilly Conditions (kWh/mile)	Assumed Flat Road	AM Route Length (mi)	Assumed Distance on Flat Roads (mi)	Assumed Distance Up & Down Hills (mi)	Energy Consumption in Average Weather (kWh)	Energy Consumption in Cold Weather (kWh)	End of Route Remaining Battery in Average Weather (kWh)	End of Route SOC in Average Weather (%)	End of Route Remaining Battery in Cold Weather (kWh)	End of Route SOC in Cold Weather (%)	PM Route Length (mi)	Assumed Distance on Flat Roads (mi)	Assumed Distance Up & Down Hills (mi)	Energy Consumption in Average Weather (kWh)	Energy Consumption in Cold Weather (kWh)	End of Route Remaining Battery in Average Weather (kWh)	End of Route SOC in Average Weather (%)	End of Route Remaining Battery in Cold Weather (kWh)	End of Route SOC in Cold Weather (%)	Daily Route Mileage (mi)	Daily Energy Consumption in Average Weather (kWh)	Daily Energy Consumption in Cold Weather (kWh)	Meets Route without Needing Midday Charge?
1a>c	238.94	1.67	0.03	2.30	4.60	60%	0	0	0	0.00	0.00	238.94	100%	238.94	100%	0	0.00	0.00	0.00	0.00	238.94	100%	238.94	100%	0.00	0.00	0.00	Yes
1a>c	238.94	1.67	0.03	2.30	4.60	60%	0	0	0	0.00	0.00	238.94	100%	238.94	100%	32	19.20	12.80	67.67	99.67	153.27	65%	122.27	52%	32.00	67.67	99.67	Yes
b1>2	238.94	1.67	0.03	2.30	4.60	60%	0	0	0	0.00	0.00	238.94	100%	238.94	100%	19	11.40	7.60	40.18	57.40	178.74	82%	161.54	74%	19.00	40.18	57.40	Yes
2b1	238.94	1.67	0.03	2.30	4.60	60%	32	19.2	12.8	67.67	99.67	153.27	65%	122.27	52%	0	0.00	0.00	0.00	0.00	238.94	100%	238.94	100%	32.00	67.67	99.67	Yes
2c>a	238.94	1.67	0.03	2.30	4.60	60%	62	37.2	24.8	131.13	187.60	87.81	35%	51.81	22%	0	0.00	0.00	0.00	0.00	238.94	100%	238.94	100%	62.00	131.13	187.60	No
a>2c	238.94	1.67	0.03	2.30	4.60	60%	35	21	14	74.01	105.73	164.93	69%	133.21	56%	20	12.00	8.00	42.29	60.42	179.65	81%	158.52	72%	55.00	116.31	166.15	Yes
2c>b	238.94	1.67	0.03	2.30	4.60	60%	0	0	0	0.00	0.00	238.94	100%	238.94	100%	112	67.20	44.80	236.83	338.33	17.95	8%	-119.05	0%	112.00	236.83	338.33	No
b1>c	238.94	1.67	0.03	2.30	4.60	60%	35	21	14	74.01	105.73	164.93	69%	133.21	56%	24	14.40	9.60	50.75	72.50	188.19	77%	166.44	67%	59.00	124.77	178.23	No
c>1	238.94	1.67	0.03	2.30	4.60	60%	96	21.9	14.6	76.13	108.75	162.81	65%	130.19	52%	11	6.60	4.40	23.26	33.23	155.68	65%	135.71	81%	67.00	99.39	141.98	Yes
c>b	238.94	1.67	0.03	2.30	4.60	60%	96	21.6	14.4	76.13	108.75	162.81	65%	130.19	52%	33	19.80	13.20	69.78	99.69	139.16	58%	139.25	56%	69.00	145.91	208.43	No
b>c	238.94	1.67	0.03	2.30	4.60	60%	32	19.2	12.8	67.67	99.67	153.27	65%	122.27	52%	32	19.20	12.80	67.67	99.67	153.27	65%	122.27	52%	64.00	135.34	199.34	Yes
c>c	238.94	1.67	0.03	2.30	4.60	60%	32	19.2	12.8	67.67	99.67	153.27	65%	122.27	52%	32	19.20	12.80	67.67	99.67	153.27	65%	122.27	52%	64.00	135.34	199.34	Yes
c>c	238.94	1.67	0.03	2.30	4.60	60%	22	13.2	8.8	46.52	68.58	172.42	76%	142.48	70%	33	19.80	13.20	69.78	99.69	169.16	68%	139.25	56%	55.00	116.31	166.15	Yes
1a>c	238.94	1.67	0.03	2.30	4.60	60%	17	10.2	6.8	35.95	51.36	182.99	84%	167.58	77%	0	0.00	0.00	0.00	0.00	238.94	100%	238.94	100%	17.00	35.95	51.36	Yes
1c>1	238.94	1.67	0.03	2.30	4.60	60%	30	18	12	63.44	90.63	151.50	71%	128.31	59%	20	12.00	8.00	42.29	60.42	176.65	81%	158.52	72%	50.00	105.73	151.05	Yes
1c>2	238.94	1.67	0.03	2.30	4.60	60%	33	19.8	13.2	69.78	99.69	149.16	68%	129.25	56%	32	19.20	12.80	67.67	99.67	153.27	65%	122.27	56%	65.00	137.45	199.36	No
2c>1	238.94	1.67	0.03	2.30	4.60	60%	31	18.6	12.4	65.55	93.65	153.38	70%	125.29	57%	45	27.00	18.00	95.16	135.92	123.78	57%	83.03	38%	76.00	160.71	229.58	No
2c>2	238.94	1.67	0.03	2.30	4.60	60%	64	38.4	25.6	135.40	193.43	103.54	43%	73.54	31%	32	19.20	12.80	67.67	99.67	153.27	65%	122.27	52%	96.00	203.07	293.10	No
2c>c	238.94	1.67	0.03	2.30	4.60	60%	98	22.8	15.2	80.34	114.80	158.58	67%	143.14	60%	44	26.40	17.60	71.90	102.71	167.04	67%	136.13	57%	72.00	152.24	217.51	Yes
2c>c	238.94	1.67	0.03	2.30	4.60	60%	23	13.8	9.2	48.64	69.48	170.30	78%	149.49	68%	26	15.60	10.40	54.98	78.56	163.96	71%	140.40	64%	49.00	103.62	148.03	Yes
2c>c	238.94	1.67	0.03	2.30	4.60	60%	21	12.6	8.4	44.41	63.44	170.53	80%	150.33	71%	25	15.00	10.00	74.01	105.73	163.93	69%	133.21	57%	56.00	118.42	169.17	Yes
2c>1	238.94	1.67	0.03	2.30	4.60	60%	80	18	12	63.44	90.63	151.50	71%	128.31	59%	25	15.00	10.00	52.87	75.52	166.07	76%	140.42	66%	55.00	116.31	166.15	Yes
2c>a	238.94	1.67	0.03	2.30	4.60	60%	58	34.8	23.2	123.65	176.21	96.29	40%	66.73	29%	33	20.00	13.00	71.00	102.71	167.93	67%	136.23	57%	92.00	194.65	277.99	No
1a>c	238.94	1.67	0.03	2.30	4.60	60%	22	13.2	8.8	46.52	66.86	172.42	76%	142.48	70%	0	0.00	0.00	0.00	0.00	238.94	100%	238.94	100%	22.00	46.52	66.48	Yes
1c>a	238.94	1.67	0.03	2.30	4.60	60%	25	15	10	52.87	75.52	166.07	70%	139.42	66%	0	0.00	0.00	0.00	0.00	238.94	100%	238.94	100%	25.00	52.87	75.52	Yes
1c>c	238.94	1.67	0.03	2.30	4.60	60%	20	10.4	9.6	50.75	72.50	168.19	77%	146.64	67%	20	12.00	8.00	42.29	60.42	179.65	81%	158.52	72%	40.00	93.04	132.92	Yes
1c>c	238.94	1.67	0.03	2.30	4.60	60%	20	10.4	9.6	50.75	72.50	168.19	77%	146.64	67%	20	12.00	8.00	42.29	60.42	179.65	81%	158.52	72%	40.00	93.04	132.92	Yes
1b>1	238.94	1.67	0.03	2.30	4.60	60%	29	17.4	11.6	61.33	87.61	157.61	72%	131.33	60%	25	15.00	10.00	52.87	75.52	166.07	76%	140.42	66%	54.00	114.19	163.14	Yes
1b>2	238.94	1.67	0.03	2.30	4.60	60%	47	28.2	18.8	99.39	141.98	139.55	55%	79.96	35%	25	15.00	10.00	52.87	75.52	166.07	76%	140.42	66%	72.00	152.26	217.51	No
1b>c	238.94	1.67	0.03	2.30	4.60	60%	28	16.8	11.2	59.21	84.59	159.73	73%	138.35	61%	24	14.40	9.60	50.75	72.50	168.19	77%	146.64	67%	52.00	109.96	157.09	Yes
2b1>c	238.94	1.67	0.03	2.30	4.60	60%	18	10.8	7.2	38.06	54.38	180.88	81%	164.94	75%	43	24.60	16.40	86.70	123.86	132.24	60%	91.08	43%	59.00	124.77	178.23	No
2b1>c	238.94	1.67	0.03	2.30	4.60	60%	32	19.2	12.8	67.67	96.67	153.27	65%	122.27	52%	21	12.60	8.40	44.41	63.46	174.51	80%	155.50	71%	53.00	112.08	160.13	Yes
1a>c	238.94	1.67	0.03	2.30	4.60	60%	0	0	0	0.00	0.00	238.94	100%	238.94	100%	0	0.00	0.00	0.00	0.00	238.94	100%	238.94	100%	0.00	0.00	0.00	Yes
1c>a	238.94	1.67	0.03	2.30	4.60	60%	32	19.2	12.8	67.67	96.67	153.27	65%	122.27	52%	32	19.20	12.80	67.67	99.67	153.27	65%	122.27	52%	64.00	135.34	199.34	Yes
1c>c	238.94	1.67	0.03	2.30	4.60	60%	33	19.8	14.4	76.13	108.75	162.81	65%	130.19	52%	24	14.40	9.60	50.75	72.50	188.19	77%	166.44	67%	57.00	126.57	186.25	Yes
1c>c	238.94	1.67	0.03	2.30	4.60	60%	7	4.2	2.8	14.80	21.16	263.14	93%	187.79	90%	0	0.00	0.00	0.00	0.00	238.94	100%	238.94	100%	7.00	14.80	21.16	Yes
1c>b	238.94	1.67	0.03	2.30	4.60	60%	0	0	0	0.00	0.00	238.94	100%	238.94	100%	16	9.60	6.40	33.83	48.34	185.11	85%	170.60	78%	16.00	33.83	48.34	Yes
1a>c	238.94	1.67	0.03	2.30	4.60	60%	0	0	0	0.00	0.00	238.94	100%	238.94	100%	0	0.00	0.00	0.00	0.00	238.94	100%	238.94	100%	0.00	0.00	0.00	Yes
1b1>c	238.94	1.67	0.03	2.30	4.60	60%	31	18.6	12.4	65.55	93.65	153.38	70%	125.29	57%	33.7	20.22	13.48	71.26	101.81	147.68	67%	117.13	54%	64.70	136.82	195.48	No
1b1>c	238.94	1.67	0.03	2.30	4.60	60%	32	19.2	12.8	67.67	96.67	153.27	65%	122.27	52%	32	19.20	12.80	67.67	99.67	153.27	65%	122.27	56%	64.00	135.34	199.34	No
1b1>c	238.94	1.67	0.03	2.30	4.60	60%	32	19.2	12.8	67.67	96.67	153.27	65%	122.27	52%	32	19.20	12.80	67.67	99.67	153.27	65%	122.27	56%	64.00	135.34	199.34	No
1>c	238.94	1.67	0.03	2.30	4.60	60%	35	21	14	74.01	105.73	164.93	69%	133.21	56%	58	34.80	23.20	122.65	175.21	96.29	40%	-63.73	26%	93.00	196.66	280.95	No
1>c	238.94	1.67	0.03	2.30	4.60	60%	26	15.6	10.4	54.98	78.56	163.96	71%	140.40	66%	19	11.40	7.60	40.18	57.40	178.74	82%	161.54	74%	45.00	95.16	135.96	Yes
1b>c	238.94	1.67	0.03	2.30	4.60	60%	15	9	6	31.72	45.31	187.22	86%	174.63	79%	105	63.00	42.00	222.04	317.20	-9.32	0%	-98.26	0%	120.00	253.76	362.51	No
1b>c	238.94	1.67	0.03	2.30	4.60	60%	28	16.8	11.2	59.21	84.59	159.73	73%	138.35	61%	57	34.20	22.80	120.56	172.19	98.82	45%	66.75	31%	85.00	179.76	256.78	No
1b>c	238.94	1.67	0.03	2.30	4.60	60%	0	0	0	0.00	0.00	238.94	100%	238.94	100%	28	16.80	11.20	59.21	84.59	154.73	71%	134.35	61%	28.00	59.21	84.59	Yes
1b>c	238.94	1.67	0.03	2.30	4.60	60%	35	21	14	74.01	105.73	164.93	69%	133.21	56%	57	34.20	22.80	120.56	172.19	98.82	45%	66.75	31%	92.00	194.57	277.92	No
1b>c	238.94	1.67	0.03	2.30	4.60	60%	0	0	0	0.00	0.00	238.94	100%	238.94	100%	57	34.20	22.80	196.44	280.63	132.30	60%	-57.17	24%	57.00	117.08	167.30	Yes
1>c	238.94	1.67	0.03	2.30	4.60	60%	36	20.4	15.6	71.90	102.71	167.04	67%	136.23	57%	30	18.00	12.00	63.44	90.63	155.50	71%	136.91	59%	66.00	135.34	193.32	Yes
1>c	238.94	1.67	0.03	2.30	4.60	60%	28	16.8	11.2	59.21	84.59	159.73	73%	138.35	61%	17	10.20	6.80	35.91	51.36	182.99	84%	167.58	77%	45.00	95.16	135.96	Yes
1>c	238.94	1.67	0.03	2.30	4.60	60%	107	64.2	42.8	229.27	323.24	-7.33	-3%	-150.30	63%	39	23.40	15.60	82.47	117.82	136.67	62%	105.12	46%	166.00	808.76	661.06	No

Charging Analysis

			Route Info		Midday Charging Analysis							Overnight Charging Analysis						
Bus #	Type	Usable Battery Capacity	AM Energy Consumption in Cold Weather (kWh)	PM Energy Consumption in Cold Weather (kWh)	SOC Needed for PM Route (kWh)	Projected SOC after AM Route (kWh)	Charge Needed for PM Route (kWh)	Mid-Day Dwell (hr)	Charger Size Needed for PM Route (kW)	Charger Size Needed for PM Route with Charging Curve (kW)	Charger Size Needed in Cold Weather (kW)	SOC Needed for AM Route (kWh)	Projected SOC after PM Route (kWh)	Charge Needed for AM Route (kWh)	Overnight Dwell (hr)	Charger Size Needed for AM Route (kW)	Charger Size Needed for PM Route with Charging Curve (kW)	Charger Size Needed in Cold Weather (kW)
263	A	155.75	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00
285	A	155.75	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00
286	A	155.75	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00
287	C	283.50	0.00	0.00	56.70	283.50	0.00	0.0	0.00	0.00	0.00	56.70	283.50	0.00	0.0	0.00	0.00	0.00
301	C	283.50	0.00	103.11	159.81	283.50	0.00	0.0	0.00	0.00	0.00	56.70	180.39	103.11	21.7	4.75	6.56	10.25
302	C	283.50	0.00	61.22	117.92	283.50	0.00	0.0	0.00	0.00	0.00	56.70	222.28	61.22	22.0	2.78	3.84	6.00
303	C	283.50	90.22	112.77	169.47	193.28	0.00	6.0	0.00	0.00	0.00	146.92	80.51	202.99	14.1	14.36	19.84	31.00
304	C	283.50	199.77	0.00	56.70	83.73	0.00	0.0	0.00	0.00	0.00	256.47	83.73	199.77	21.3	9.40	12.98	20.29
309	C	283.50	112.77	64.44	121.14	170.73	0.00	5.9	0.00	0.00	0.00	169.47	106.28	177.22	14.3	12.39	17.12	26.75
310	C	283.50	0.00	360.88	283.50	283.50	0.00	0.0	0.00	0.00	0.00	56.70	-77.38	283.50	20.7	13.67	18.89	29.51
311	C	283.50	112.77	77.33	134.03	170.73	0.00	5.7	0.00	0.00	0.00	169.47	93.39	190.11	14.3	13.33	18.40	28.76
312	C	283.50	116.00	35.44	92.14	167.50	0.00	5.7	0.00	0.00	0.00	172.70	132.06	151.44	15.3	9.92	13.70	21.41
315	A	155.75	0.00	130.57	155.75	155.75	0.00	13.0	0.00	0.00	0.00	31.15	25.18	130.57	20.3	6.42	8.87	13.86
316	A	155.75	64.46	0.00	31.15	91.29	0.00	0.0	0.00	0.00	0.00	95.61	91.29	64.46	21.9	2.95	4.07	6.37
317	A	155.75	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00
318	C	283.50	116.00	106.33	163.03	167.50	0.00	5.7	0.00	0.00	0.00	172.70	61.17	222.33	14.1	15.73	21.73	33.95
319	C	283.50	116.00	116.00	172.70	167.50	5.19	5.7	0.92	1.27	1.98	172.70	56.70	226.80	14.5	15.70	21.68	33.87
321	A	155.75	175.19	128.91	155.75	-19.44	155.75	4.2	37.38	51.63	80.67	206.34	7.40	148.35	14.9	9.95	13.74	21.46
322	A	155.75	74.37	71.07	102.22	81.38	20.84	5.6	3.70	5.11	7.98	105.52	31.15	124.60	13.4	9.30	12.84	20.07
323	A	155.75	85.94	79.33	110.48	69.81	40.67	4.7	8.65	11.95	18.68	117.09	31.15	124.60	14.1	8.84	12.21	19.07
324	A	155.75	74.37	52.89	84.04	81.38	2.66	6.0	0.44	0.61	0.95	105.52	31.15	124.60	14.3	8.73	12.06	18.85
325	A	155.75	117.34	142.14	155.75	38.41	117.34	3.4	34.34	47.44	74.12	148.49	13.61	142.14	13.5	10.54	14.56	22.75
326	A	155.75	142.14	123.96	155.11	13.61	141.49	4.7	30.32	41.88	65.43	173.29	31.15	124.60	13.8	9.02	12.46	19.46
327	A	155.75	38.01	41.32	72.47	117.74	0.00	7.2	0.00	0.00	0.00	69.16	76.42	79.33	15.0	5.28	7.29	11.39
330	C	283.50	103.11	99.89	156.59	180.39	0.00	5.7	0.00	0.00	0.00	159.81	80.51	202.99	14.2	14.28	19.72	30.82
331	C	283.50	70.89	106.33	163.03	212.61	0.00	5.7	0.00	0.00	0.00	127.59	106.28	177.22	13.7	12.90	17.82	27.85
332	A	155.75	74.37	155.36	155.75	81.38	74.37	4.2	17.71	24.46	38.22	105.52	0.39	155.36	13.4	11.59	16.01	25.02
333	A	155.75	104.12	105.78	136.93	51.63	85.30	5.3	15.99	22.09	34.52	135.27	31.15	124.60	14.3	8.72	12.05	18.83
334	A	155.75	138.83	135.52	155.75	16.92	138.83	3.5	39.67	54.79	85.60	169.98	20.23	135.52	14.6	9.27	12.81	20.01
336	C	155.75	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00
337	A	155.75	123.96	109.08	140.23	31.79	108.44	4.8	22.83	31.53	49.27	155.11	31.15	124.60	15.1	8.23	11.37	17.77
340	C	283.50	54.78	0.00	56.70	228.72	0.00	0.0	0.00	0.00	0.00	111.48	228.72	54.78	22.1	2.48	3.42	5.35
341	C	283.50	96.66	64.44	121.14	186.84	0.00	5.9	0.00	0.00	0.00	153.36	122.39	161.11	14.6	11.05	15.26	23.84
342	C	283.50	106.33	103.11	159.81	177.17	0.00	5.9	0.00	0.00	0.00	163.03	74.06	209.44	14.2	14.77	20.40	31.87
343	C	283.50	99.89	145.00	201.70	183.61	18.08	5.9	3.08	4.26	6.65	156.59	56.70	226.80	14.0	16.22	22.40	35.00
344	A	155.75	77.68	115.69	146.84	78.07	68.77	4.3	15.87	21.92	34.25	108.83	31.15	124.60	14.1	8.82	12.18	19.03
345	A	155.75	114.04	77.68	108.83	41.71	67.12	5.3	12.58	17.38	27.16	145.19	31.15	124.60	13.9	8.95	12.37	19.32
346	C	283.50	125.66	109.55	166.25	157.84	8.42	6.0	1.41	1.95	3.05	182.36	56.70	226.80	13.8	16.49	22.78	35.60
347	A	155.75	36.36	0.00	31.15	119.39	0.00	0.0	0.00	0.00	0.00	67.51	119.39	36.36	22.8	1.59	2.20	3.44
348	C	283.50	122.44	109.55	166.25	161.06	5.19	5.7	0.91	1.25	1.95	179.14	56.70	226.80	14.0	16.22	22.40	35.00
349	C	283.50	74.11	83.78	140.48	209.39	0.00	5.8	0.00	0.00	0.00	130.81	125.62	157.88	14.6	10.79	14.90	23.29
350	C	283.50	67.66	112.77	169.47	215.84	0.00	6.0	0.00	0.00	0.00	124.36	103.06	180.44	14.3	12.63	17.45	27.26
351	C	283.50	96.66	80.55	137.25	186.84	0.00	5.9	0.00	0.00	0.00	153.36	106.28	177.22	14.2	12.49	17.26	26.97
352	A	155.75	85.94	84.29	115.44	69.81	45.63	3.8	12.17	16.81	26.26	117.09	31.15	124.60	15.5	8.05	11.12	17.37
353	A	155.75	74.37	190.07	155.75	81.38	74.37	5.0	14.87	20.55	32.10	105.52	-34.32	155.75	13.1	11.86	16.38	25.59
354	A	155.75	109.08	133.87	155.75	46.67	109.08	5.0	22.04	30.44	47.56	140.23	21.88	133.87	13.3	10.09	13.94	21.78
355	A	155.75	77.68	107.43	138.58	78.07	60.51	5.5	10.93	15.10	23.60	108.83	31.15	124.60	14.4	8.65	11.95	18.67
356	C	283.50	186.88	109.55	166.25	96.62	69.64	5.7	12.33	17.02	26.60	243.58	56.70	226.80	13.7	16.57	22.89	35.77
357	C	283.50	70.89	0.00	56.70	212.61	0.00	0.0	0.00	0.00	0.00	127.59	212.61	70.89	22.1	3.21	4.43	6.93
358	C	283.50	80.55	0.00	56.70	202.95	0.00	0.0	0.00	0.00	0.00	137.25	202.95	80.55	21.8	3.70	5.10	7.97
359	C	283.50	77.33	64.44	121.14	206.17	0.00	5.9	0.00	0.00	0.00	134.03	141.73	141.77	14.4	9.85	13.60	21.25
360	C	283.50	87.00	74.11	130.81	196.50	0.00	5.9	0.00	0.00	0.00	143.70	122.39	161.11	14.3	11.31	15.62	24.40
361	C	283.50	93.44	80.55	137.25	190.06	0.00	5.7	0.00	0.00	0.00	150.14	109.50	174.00	14.1	12.34	17.04	26.63
362	C	283.50	151.44	80.55	137.25	132.06	5.19	5.7	0.91	1.25	1.95	208.14	56.70	226.80	14.0	16.18	22.35	34.92
363	A	155.75	180.15	95.86	127.01	-24.40	151.41	3.8	39.50	54.55	85.24	211.30	31.15	124.60	14.1	8.87	12.25	19.14
364	C	283.50	90.22	77.33	134.03	193.28	0.00	5.6	0.00	0.00	0.00	146.92	115.95	167.55	14.2	11.79	16.28	25.43
365	C	283.50	58.00	132.11	188.81	225.50	0.00	5.7	0.00	0.00	0.00	114.70	93.39	190.11	13.3	14.26	19.69	30.77
366	C	283.50	103.11	67.66	124.36	180.39	0.00	6.0	0.00	0.00	0.00	159.81	112.73	170.77	13.9	12.32	17.01	26.58
367	C	283.50	0.00	0.00	56.70	283.50	0.00	0.0	0.00	0.00	0.00	56.70	283.50	0.00	0.0	0.00	0.00	0.00
368	A	155.75	52.89	92.55	123.70	102.86	20.84	5.0	4.14	5.72	8.94	84.04	31.15	124.60	14.1	8.82	12.18	19.03
369	A	155.75	46.28	72.72	103.87	109.47	0.00	5.3	0.00	0.00	0.00	77.43	36.75	119.00	14.3	8.30	11.47	17.92
370	A	155.75	123.96	140.48	155.75	31.79	123.96	4.4	28.07	38.76	60.57	155.11	15.27	140.48	14.4	9.73	13.44	21.01
371	A	155.75	128.91	123.96	155.11	26.84	128.27	4.8	27.00	37.30	58.28	160.06	31.15	124.60	14.8	8.40	11.60	18.13
372	A	155.75	67.76	90.90	122.05	87.99	34.06	4.3	7.86	10.86	16.96	98.91	31.15	124.60	14.0	8.89	12.28	19.18
373	A	155.75	152.05	160.32	155.75	3.70	152.05	4.3	35.78	49.42	77.21	183.20	-4.57	155.75	14.6	10.68	14.75	23.05
374	A	155.75	97.51	49.58	80.73	58.24	22.49	4.5	5.00	6.90	10.79	128.66	31.15	124.60	14.8	8.45	11.67	18.23
375	C	283.50	77.33	109.55	166.25	206.17	0.00	5.7	0.00	0.00	0.00	134.03	96.62	186.88	14.2	13.21	18.24	28.50
376	C	283.50	99.89	77.33	134.03	183.61	0.00	5.7	0.00	0.00	0.00	156.59	106.28	177.22	14.3	12.41	17.14	26.78
377	C	283.50	0.00	93.44	150.14	283.50	0.00	14.7	0.00	0.00	0.00	56.70	190.06	93.44	7.7	12.14	16.76	26.19
378	C	283.50	22.55	0.00	56.70	260.95	0.00	0.0	0.00	0.00	0.00	79.25	260.95	22.55	23.6	0.96	1.32	2.06
379	C	283.50	0.00	51.55	108.25	283.50	0.00	0.0	0.00	0.00	0.00	56.70	231.95	51.55	23.3	2.21	3.06	4.78
380	C	283.50	0.00	0.00	56.70	283.50	0.00	0.0	0.00	0.00	0.00	56.70	283.50	0.00	0.0	0.00	0.00	0.00
381	C	283.50	99.89	108.59	165.29	183.61	0.00	5.7	0.00	0.00	0.00	156.59	75.03	208.47	13.4	15.56	21.49	33.58
382	C	283.50	93.44	106.33	163.03	190.06	0.00	5.9	0.00	0.00	0.00	150.14	83.73	199.77	14.3	14.00	19.34	30.22
383	C	283.50	99.89	103.11	159.81	183.61	0.00	6.0	0.00	0.00	0.00	156.59	80.51	202.99	13.8	14.76	20.39	31.86
384	C	283.50	112.77	186.88	243.58	170.73	72.86	4.0	18.45	25.48	39.81	169.47	56.70	226.80	14.1	16.09	22.22	34.71
385	A	155.75	82.64	41.32	72.47	73.11	0.00	5.3	0.00	0.00	0.00	113.79	31.79	123.96	15.7	7.90	10.91	17.04
386	C	283.50	83.78	61.22	117.92	199.72	0.00	6.0	0.00	0.00	0.00	140.48	138.50	145.00	14.3	10.12	13.97	21.83
387	C	283.50	48.33	338.32	283.50	235.17	48.33	6.8	7.07	9.77	15.26	105.03	-54.82	283.50	13.2	21.53	29.74	46.47
388	C	283.50	90.22	183.66	240.36	193.28	47.08	4.2	11.30	15.61	24.39	146.92	56.70	226.80	14.5	15.64	21.60	33.76
389	A	155.75	87.60	76.03	107.18	68.15	39.02	3.8	10.18	14.06	21.97	118.75	31.15	124.60	14.5	8.59	11.87	18.55
390	A	155.75	74.37	0.00	31.15	81.38	0.00	0.0	0.00	0.00	0.00	105.52	81.38	74.37	22.0	3.39	4.68	7.31
391	A	155.75	180.15	114.04	145.19	-24.40	155.75	4.0	38.94	53.78	84.03	211.30	17.31	138.44	14.6	9.51	13.14	20.53
392	A	155.75	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00	31.15	155.75	0.00	0.0	0.00	0.00	0.00
393	A	155.75	77.68	112.39	143.54	78.07	65.47	4.1	16.03	22.14	34.60	108.83	31.15	124.60	14.0	8.92	12.32	19.25
394	C	283.50	0.00	90.22	146.92	283.50	0.00	0.0	0.00	0.00	0.00	56.70	193.28	90.22	22.2	4.06	5.61	8.76
395	C	283.50	80.55	299.66	283.50	202.95	80.55	5.9	13.73	18.97	29.63	137.25	-16.16	283.50	13.2	21.53	29.74	46.47
396	C	283.50	0.00	119.22	175.92	283.50	0.00	0.0	0.00	0.00	0.00	56.70	164.28	119.22	22.1	5.39	7.45	11.63
397	C	283.50	109.55	96.66	153.36	173.95	0.00	5.9	0.00	0.00	0.00	166.25	77.28	206.22	13.8	14.91	20.59	32.17
398	C	283.50	90.22	54.78	111.48	193.28	0.00	5.6	0.00	0.00	0.00	146.92	138.50	145.00	14.1	10.31	14.24	22.25
399	C	283.50	344.77	125.66	182.36	-61.27	243.63	4.0	61.68	85.19	133.11	401.47	56.70	226.80	14.2	15.93	22.01	34.39

September 12, 2025

Enclosed please find the results of a high-level capacity assessment and rate analysis.

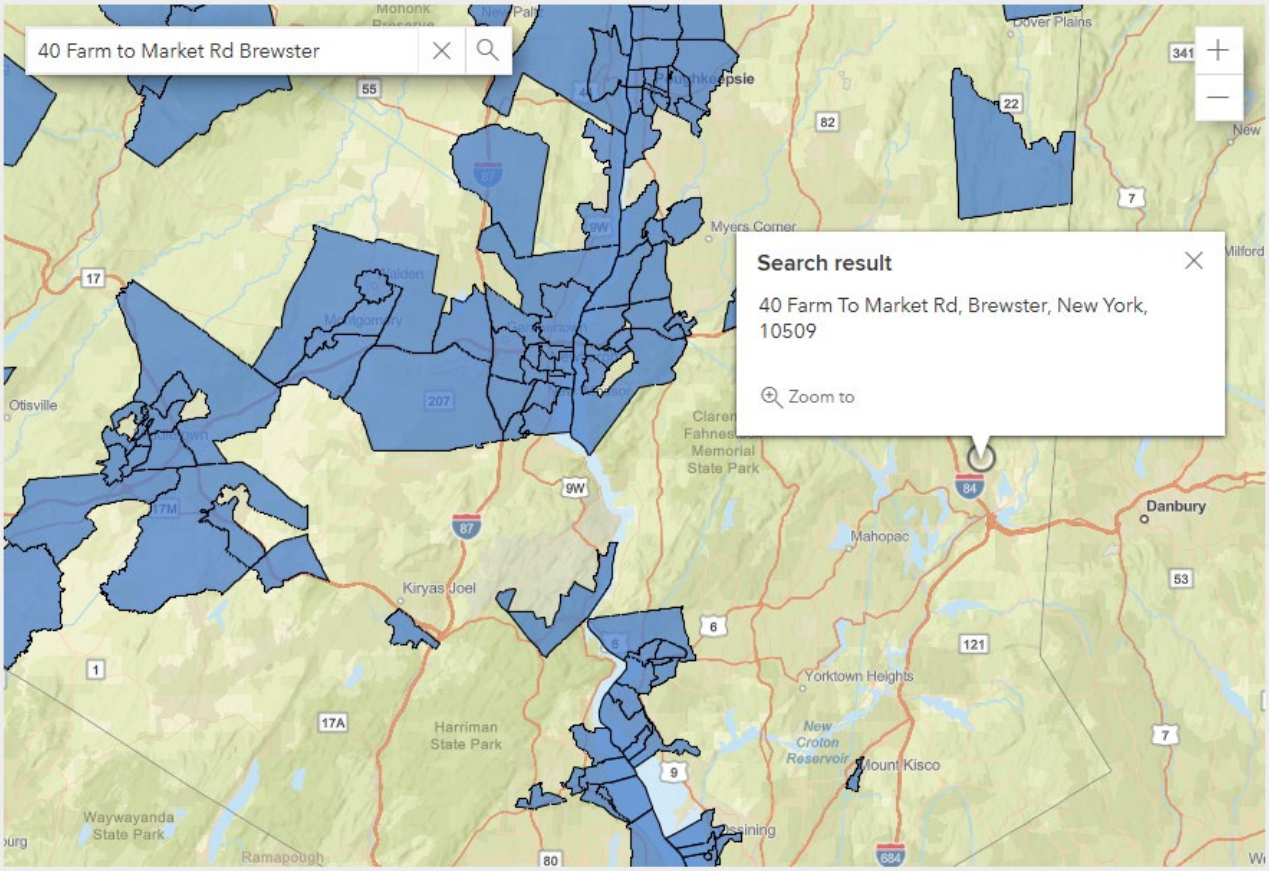
The below assessment and analysis were completed for:

School Name	Brewster Central School District
Address	40 Farm to Market Rd Brewster
Number of Vehicles	90
Peak Demand	2880 kW
Reduced Peak Demand	2534.06 kW
Total Customer Requested Load	2880 kW

Proximity to Disadvantaged Community

40 Farm To Market Rd, Brewster, New York, 10509

This address does not meet the criteria identified for a disadvantaged community.



Site Feasibility Assessment

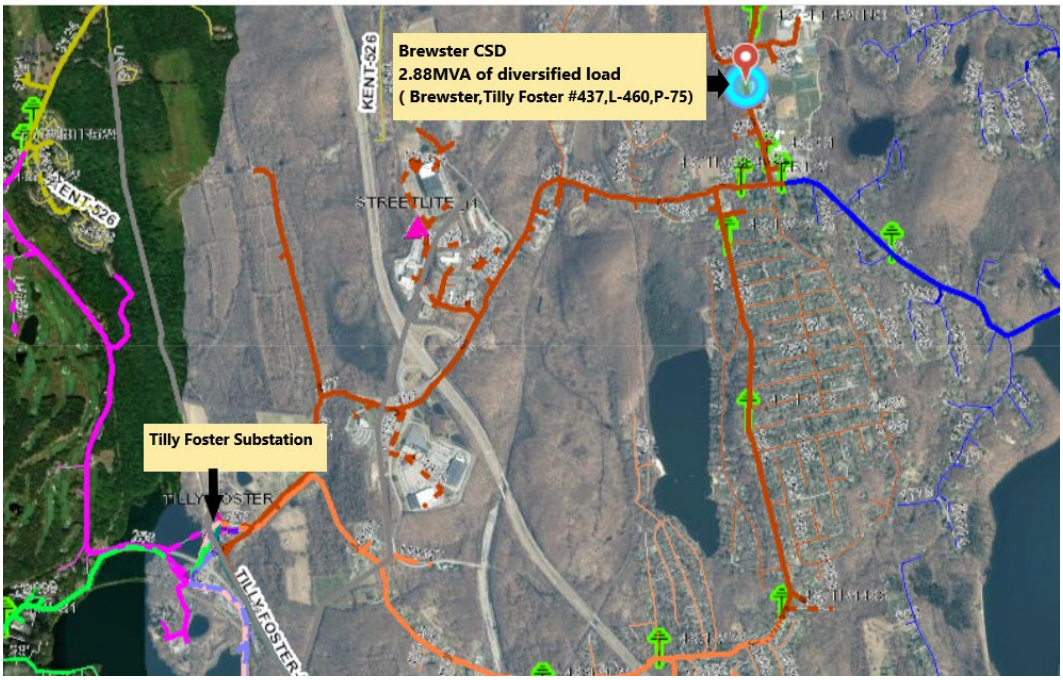
Capacity Study Summary – 6092#Brewster CSD - High-Level Capacity Assessment

Location: The address where the customer requested the study is Brewster Central School District, 40 Farm to Market Rd Brewster.

The customer's neighborhood is fed by circuit Tilly Foster #437(1107237) from Tilly Foster Bank #1(11072T1).

The proposed total connected load for this capacity study is 2880kVA based on customer information. This load is for EV transportation and was diversified. The Brewster CSD High Level Capacity Assessment Load (2.88 MVA with a unity power factor) has no adverse impact on the transmission system when added to Tilly Foster 115kV station.

The Tilly Foster #437(1107237) nearest to the proposed customer location is shown in the picture below.



Queued Load: There are queued loads on circuit Tilly Foster #437(1107237) or on transformer Tilly Foster Bank #1(11072T1).

- 3.430MVA queued load - 1066 – Pugsley Rd Brewster on Tilly Foster Feeder#437(1107237)/ (11072T1)
- 3.673MVA queued load - 3725 – Oakmont (formerly Gateway Summit) on Tilly Foster Feeder#442(1107242)/ (11072T1)
- 0.693MVA queued load - 2851 – Ace Endico Expansion on Tilly Foster Feeder#437(1107237)/ (11072T1)

Loading: A summary of the capacity at this location by each circuit and substation transformer is provided below:

- 2025: Request 1440 kW utility new service for Phase 1 and Phase 2.

Phase I(2026):

- Customer Demand without charge management: 0.240MVA
    - Tilly Foster #437 Loading: 12.61MVA (95%)
    - Tilly Foster Bank#1 Loading: 34.98MVA (93%)
- Customer Demand with charge management: 0.092MVA
    - Tilly Foster #437 Loading: 12.47 MVA (94%)
    - Tilly Foster Bank#1 Loading: 34.83 MVA (93%)

Phase 2.1(2028):

- Customer Demand without charge management: 0. 840MVA
    - Tilly Foster #437 Loading: 13.55 MVA (102%)
    - Tilly Foster Bank#1 Loading: 36.67 MVA (98%)
- Customer Demand with charge management: 0.490MVA
    - Tilly Foster #437 Loading: 13.20 MVA (99%)
    - Tilly Foster Bank#1 Loading: 36.32MVA (97%)

Phase 2.2(2030):

- Customer Demand without charge management: 1.440MVA
    - Tilly Foster #437 Loading: 14.12 MVA (106%)
    - Tilly Foster Bank#1 Loading: 38.4 MVA (102%)
- Customer Demand with charge management: 1.065MVA
    - Tilly Foster #437 Loading: 14.49MVA (109%)
    - Tilly Foster Bank#1 Loading: 38.03 MVA (101%)

For Phase 1, there is enough distribution capacity at the feeder circuit Tilly Foster #437 and Tilly Foster Bank#1 substation transformer to accommodate this Anticipated load demand. But not with Phase 2.

- 2030: Request 1440 kW utility upgrade (2880 kW service total) for Phase 3 and Phase 4.

Phase 3.1(2032):

- Customer Demand without charge management: 2.040MVA
    - Tilly Foster #437 Loading: 15.45 MVA (116%)
    - Tilly Foster Bank#1 Loading: 40.18 MVA (107%)
- Customer Demand with charge management: 1.600MVA
    - Tilly Foster #437 Loading: 15.01 MVA (113%)
    - Tilly Foster Bank#1 Loading: 39.74 MVA (106%)

Phase 3.2(2034):

- Customer Demand without charge management: 2.280MVA
    - Tilly Foster #437 Loading: 16.07 MVA (121%)
    - Tilly Foster Bank#1 Loading: 41.65 MVA (111%)
- Customer Demand with charge management: 1.744MVA
    - Tilly Foster #437 Loading: 15.53 MVA (117%)
    - Tilly Foster Bank#1 Loading: 41.11 MVA (109%)

Phase 4(2035):

- Customer Demand without charge management:2.880MVA
    - Tilly Foster #437 Loading: 16.86 MVA (127%)
    - Tilly Foster Bank#1 Loading: 42.88 MVA (114%)

- Customer Demand with charge management: 2.534MVA
    - Tilly Foster #437 Loading: 16.52 MVA (124%)
    - Tilly Foster Bank#1 Loading: 42.53 MVA (113%)

For Phase 3 and 4, there is not enough distribution capacity at the feeder circuit Tilly Foster #437 and Tilly Foster Bank#1 substation transformer to accommodate this Anticipated load demand.

Total Connected Load :2.88MVA

	VOLTAGE (KV)	READ TYPE	RATING (MVA)	EXISTING PEAK LOAD (2024) (MVA)	EXISTING THERMAL %	QUEUED LOAD (MVA)	PROPOSED LOAD (MVA)	NEW PEAK LOAD (MVA)(1)	NEW THERMAL (%)	CAPACITY (MVA)
11072 T1	115/13.2	CHNR NR (2023)	37.584	25.90	68.90 %	7.796	2.88	42.88	114%	-5.30
11072 37	13.2	CHNR NR (2023)	13.3	7.93	59.65 %	4.123	2.88	16.86	127%	-3.56

Conclusion:

Adding 2.88 MVA would:

- Increase the loading on Tilly Foster Bank#1 = 42.88MVA; 114% of the capacity.
- Increase circuit Tilly Foster #437 to 16.86MVA; 127% of the capacity.

Considering the proposed total load to be connected, it is not possible to connect to Tilly Foster #437 without increasing the thermal load above 100%. Without considering voltage and flicker constraints, it does not seem like there is enough capacity for the load under normal conditions for Tilly Foster Bank#1.

Note: This summary does not reserve any capacity on the circuit/substation. If the developer is interested in moving this project forward, they would need to submit a detailed load sheet for a new load study to be completed. This would determine any upgrades that may be necessary such as requirements of thermal, voltage mitigations, conductor upgrades, etc.

Rate Analysis

PLEASE NOTE THE BELOW ARE REFLECTIVE OF DELIVERY CHARGES ONLY. SUPPLY CHARGES ARE NOT INCLUDED AND WOULD BE CALCULATED AT THE TIME OF BILLING BASED ON CURRENT SUPPLY RATES

Phase 1

Straight Demand Billing			
# of vehicles	12	Monthly Bill Estimates	
With Demand Reduction (kW)	92.122	With Demand Reduction (kW)	$ 1,810.47
Without Demand Reduction (kW)	240	Without Demand Reduction (kW)	$ 4,043.43

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Phase 2

Straight Demand Billing			
# of vehicles	52	Monthly Bill Estimates	
With Demand Reduction (kW)	489.739	With Demand Reduction (kW)	$ 7,921.19
Without Demand Reduction (kW)	840	Without Demand Reduction (kW)	$ 13,210.14

Phase 3

Straight Demand Billing			
# of vehicles	80	Monthly Bill Estimates	
With Demand Reduction (kW)	1743.644	With Demand Reduction (kW)	$ 26,929.85
Without Demand Reduction (kW)	2280	Without Demand Reduction (kW)	$ 35,028.83

Phase 4

Straight Demand Billing			
# of vehicles	90	Monthly Bill Estimates	
With Demand Reduction (kW)	2534.058	With Demand Reduction (kW)	$ 38,891.78
Without Demand Reduction (kW)	2880	Without Demand Reduction (kW)	$ 44,115.50

Notes:
1. kWh demand charges are based on example rate components which are subject to change once the PIR is active in Q4 2025
2. Estimated costs are based on 180 school days in a year, 10 months of operation per year, 18 operating days per month
3. kWh per mile for electric school buses is dependent on many factors including bus weight, terrain, driving conditions, weather, and other factors
4. Charges including monthly customer charge and other various charges are not included and generally make up a small percentage of overall monthly bills
5. Demand charges are based on example rate components which are subject to change once the PIR is active in Q4 2025
6. On, off, and super peak kwh usage is based off an example 24-hour load profile provided by the FEP consultant. These are in no way a representation or a guarantee of actual charging scenarios

Programs and Incentives

Electric Vehicle Charging Station Make-Ready Program

Demand Charge Rebate

Load Management Technologies Incentive Program

Phase-In Rate *Coming Fall 2025*

For more information on the above programs and incentives please contact evprograms@nyseg.com

Sincerely,

Michael Jachles and Krystal Alba

2 School Bus Voucher Requirements and Amounts

A School Bus Voucher will be issued for the net eligible incremental cost of an ESB after all other incentives are accounted for and after the application has been determined to meet all program eligibility criteria. If the Purchaser qualifies for the Equipment Add-Ons described below, the Purchaser will be issued a voucher for the net eligible incremental cost plus the total amount of funding for the qualifying Equipment Add-Ons. The incentive amounts shown below may change over time. Once a School Bus Voucher is approved, that School Bus Voucher is eligible for the incentive amount shown in the Implementation Manual at the time of the School Bus Voucher Application submission.

2.1 Base School Bus Voucher Amounts

The base School Bus Voucher amounts for NYSBIP are intended to cover a large percentage of the incremental cost of an ESB. School Bus Voucher amounts are categorized by type of bus (e.g., Type A, Type C, Type D) and by whether the ESB is purchased new or if it is an existing school bus that is being repowered. The base School Bus Voucher amounts are shown in Table 2. The base School Bus Voucher amounts were determined by subtracting the average price of all internal combustion engine (ICE) school buses on the OGS State School Bus Contract in each category from the average price of all ESBs in that category. Repowered School Bus incremental values were determined based on industry research. The maximum School Bus Voucher amounts, once all available School Bus Voucher Bonuses (Bonus) and Complementary School Bus Voucher Add-Ons (Add-Ons) are applied, are shown in Table 3. NYSERDA reserves the right to change the incentive amounts shown below.

Table 2. Base School Bus Voucher Amounts

School Bus Type	Percentage of Incremental Cost Covered	Base School Bus Voucher Dollar Amount
New Type A (NTA)	60%	$114,000
New Type C (NTC)	60%	$147,000
New Type D (NTD)	60%	$156,000
Repowered Type A (RTA)	75%	$105,000
Repowered Type C (RTC)	75%	$135,000

Table 3. School Bus Voucher Bonus and Add-On Amounts

School Bus Type	Priority District Bonus Amount	Scrappage Bonus Amount	V2G Add-On Amount	Wheelchair Add-On Amount
NTA	$28,500	$47,500	$9,500	$8,000
NTC	$36,750	$61,250	$12,250	$8,000
NTD	$39,000	$65,000	$13,000	$8,000
RTA	$21,000	N/A	$7,000	N/A
RTC	$27,000	N/A	$9,000	N/A

*Refer to section 2.3.

2.2 School Bus Voucher Rules

Purchasers must comply with the following rules of the School Bus Voucher:

- The eligible ESB must travel at least 5,000 miles per year for the 5 years of required reporting to NYSBIP.
- An ESB must be purchased from a Dealer approved to participate in NYSBIP (refer to section 6).
- Repowered School Buses may be eligible for funding if the school bus has an expected operational lifespan after repowering of at least five (5) years. For the purposes of Repowered School Buses, the entire cost of the repower is considered the incremental cost.
- NYSBIP funding may not be used to pay for the purchase or installation of fuel-fired heaters, although these may be installed at Purchaser's cost.

2.3 School Bus Voucher Bonus Amounts

School Bus voucher amounts can be increased through Bonuses that can be obtained through meeting additional criteria or taking additional actions. The Bonuses are defined in this section, which includes information on Purchaser and school bus eligibility and Bonus amounts (which are added to the Base School Bus Voucher dollar amounts in Table 1). A Purchaser may receive all, some, or none of the Bonuses depending on whether it meets the criteria.

2.3.1 Priority District Bonus

Priority District buses are buses that serve Priority Districts as defined in section 7.1.1.

- **Eligible school buses**: All bus types are eligible for this bonus.
- **Eligible Purchasers**: Those meeting the Priority Districts criteria included in section 7.1.1.
- **Bonus amounts**: An additional 15% of the incremental cost will be applied to the base School Bus Voucher amount as depicted in Table 4.

Table 4. Priority District Bonus Amounts

School Bus Type	Bonus Amount
NTA	$28,500
NTC	$36,750
NTD	$39,000
RTA	$21,000
RTC	$27,000

2.3.2 Scrappage Bonus

The Scrappage Bonus applies when a Purchaser destroys the school bus being replaced, ensuring that the school bus will not be sold or used elsewhere.

- **Eligible school buses:** New Type A, C, and D buses qualify. Repowered School Buses do not qualify. For additional eligibility requirements refer to section 5.1.
- **Eligible Purchasers:** All Purchasers applying for a School Bus Voucher for a new bus (e.g., not Repowered School Buses) qualify.
- **Bonus amounts:** An additional 25% of the incremental cost will be applied to the base School Bus Voucher amount as depicted in Table 5.
- **Documentation:** Refer to section 9.1.1

Table 5. School Bus Scrappage Bonus Amounts

School Bus Type	Bonus Amount
NTA	$47,500
NTC	$61,250
NTD	$65,000
RTA	N/A
RTC	N/A

2.3.2.1 Scrappage Bonus Requirements

To receive the Scrappage Bonus the Purchaser must scrap an in-service school bus, as defined below.

Scrappage Definition

A school bus is considered scrapped when rendered inoperable and available for recycling, by cutting a three-inch hole in the engine block and disabling the chassis by cutting the school bus's frame rails completely in half.

- To destroy the engine: Cut or drill a minimum three-inch hole through the engine block.
- To destroy the chassis: Cut or shear both the chassis rails between the two axles.

The school bus to be scrapped must meet the following requirements at the date of application to qualify for the Scrappage Bonus portion of the School Bus Voucher:

- The school bus must be owned by the Purchaser or the school district that the Purchaser is providing transportation services for and must be an in-service school bus, meaning:
  - The school bus was operated in the school district to be served by the ESB within the last twelve (12) months. If the Purchaser is a Third-Party Operator that has not previously served the school district where the ESB will serve, the Purchaser may scrap a school bus domiciled in the same or adjacent county to the school district where the ESB will serve;
  - The school bus was operated in NYS during twenty-four (24) of the previous thirty-six (36) months; and
  - The school bus has been driven 2,500 miles or more in the last twelve (12) months.
  - If a bus to be scrapped cannot meet the above mileage requirement, then Purchasers may scrap a bus that meets the following criteria:
    - engine model year ten (10) years or older from the current calendar year and;
  - Buses with an odometer reading over 110,000 miles
- The school bus engine must be a model year at least seven (7) years older than the year of application (e.g., if applying in 2024 the bus engine must be model year 2017 or older).
- Existing school buses must be replaced with the same school bus type or a smaller type (e.g., a Type C bus may be scrapped to receive the bonus for a Type A bus, but a Type A bus cannot be scrapped for a Type C bus application).
- The school bus must be an internal combustion engine bus using any fuel type (scrappage of diesel school bus is preferred where feasible).
- Additional information regarding the scrappage process requirements and documentation can be found in section 9.1.

2.4 Complementary School Bus Voucher Add-Ons

In addition to the Bonus amounts, two additional School Bus Voucher Add-Ons (Add-Ons) are available for Purchasers that request specialized equipment be installed on their ESBs. The amounts are intended to help cover the additional expenses associated with these school bus modifications:

2.4.1 Vehicle-to-Grid Technology Add-On

This Add-On applies to ESBs that include vehicle-to-grid (V2G) capability. NYSERDA will determine whether ESB models are V2G-capable (or whether they come with the option of being V2G-capable) when it reviews each Vehicle Eligibility Application. NYSERDA will indicate the V2G status on the Eligible ESB List.

- Eligible school buses: All school bus types are eligible for this bonus.
- Eligible Purchasers: All Purchasers applying for a School Bus Voucher qualify.
- Add-on amounts: An additional 5% of the incremental cost will be applied to the base School Bus Voucher amount as depicted in Table 6.

Table 6. V2G Technology Complementary Add-On Amounts

School Bus Type	Add-On Amount
NTA	$9,500
NTC	$12,250
NTD	$13,000
RTA	$7,000
RTC	$9,000

2.4.2 Wheelchair Accessibility Add-On

This Add-On applies for ESBs that are wheelchair accessible.

- **Eligible school buses**: New Type A, C, and D buses. Repowered School Buses do not qualify.
- **Eligible Purchasers**: All Purchasers applying for a School Bus Voucher qualify.
- **Add-on Amounts**: An additional $8,000 will be added to the base School Bus Voucher amount as depicted in Table 7.

Table 7. Wheelchair Accessibility Add-On Amounts

School Bus Type	Add-On Amount
NTA	$8,000
NTC	$8,000
NTD	$8,000

RTA	N/A
RTC	N/A

2.5 School Bus Voucher Caps

In line with the goal of NYSBIP to enable all school districts an opportunity to participate, the following caps will be placed on the number of ESB Vouchers each Purchaser may seek. The voucher caps listed below apply until December 1, 2025. After December 1, 2025, Purchasers may apply for additional ESB Vouchers if funding remains. All Purchasers must submit a completed Fleet Certification at the time of application for NYSERDA to determine the following caps (refer to Section 8.1).

- District Caps
  - Each non-priority school district may apply for the greater of six (6) ESBs or 6% of their fleet.
  - Each Priority District may apply for the greater of ten (10) ESBs or 10% of their fleet.
  - School districts can apply for the greater of an additional 4% or four (4) ESBs if they complete an approved Fleet Electrification Plan (refer to section 3.1.1).
  - NYSBIP Stacking Vouchers (refer to Section 1.3.2.1) count toward the District Cap.
- Sub-District Caps
  - In districts where pupil transportation is provided by more than one party, including one or more Third-Party Operator and/or the district, the total number of School Bus Vouchers will be determined using the 'District Cap' guidelines above. Additionally, each provider will also have a 'Sub-District Cap' that is determined by the share of vehicles they operate (see 'Mixed Fleet Example' at the end of this section).
  - Each provider may apply for the greater of six (6) ESBs or 6% of its fleet serving each non-priority school district with which it contracts.
  - Each provider may apply for the greater of ten (10) ESBs or 10% of its fleet serving each Priority District with which it contracts.
  - Providers may apply for the greater of an additional four (4) ESBs or 4% of its school buses serving each school district with which it contracts If they complete an approved Fleet Electrification Plan.
  - For the purposes of the NYSBIP program, NYSERDA considers New York City (NYC) as one school district.
  - No district may receive more than 25% of total program funding.
  - NYSBIP Stacking Vouchers (refer to Section 1.3.2.1) count toward the District Cap.
  - Funding caps will remain in place until December 1, 2025, at which point NYSERDA will reassess based on program demand and geographic distribution of funding to date.
- Mixed Fleet Example:
  - School District A, a Priority District, requires 300 buses for pupil transportation (District Fleet = 300, District Cap = 30 School Bus Vouchers).

- School District A's pupil transportation is provided by Third-Pary A (200 buses), Third-Pary B (70 buses), the District (30 buses), so the Sub-District Caps are:
  - Third-Party A = up to 20 School Bus Vouchers
  - Third-Party B = up to 10 School Bus Vouchers
  - School District A = up to 10 School Bus Vouchers
- While the sum of the Sub-District Caps is 40 School Bus Vouchers, the District Cap is 30 School Bus Vouchers. If School District A wants to claim all 30 School Bus Vouchers, it must coordinate with its Third-Party Operators to stay within the District Cap. This coordination is documented and approved by the district and the Third-Party Operator by completing the Third-Party Operator Addendum (refer to Section 8.1).

These caps will be reviewed and, if funding allows, lifted, once efforts to reach every school district have been made.

2.6 Declining School Bus Voucher Incentives

The total cost of ownership (TCO) of ESBs is expected to reach parity with that of ICE buses around 2027 and ownership of ESBs is expected to become more favorable beyond 2027. Since the upfront purchase price of an ESB is the main driver of TCO, NYSBIP anticipates lowering incentive amounts as the market purchase prices for new ESB's decreases. NYSERDA will monitor costs on an annual basis while NYSBIP is active and adjust incentive amounts accordingly. While no declining amounts are currently scheduled, it is important for Purchasers to understand that incentive amounts may decrease.



LEGEND	
□	60KW DUAL PORT DCFC
○	120KW DUAL PORT DCFC
△	40KW DUAL PORT DCFC

PHASED IMPLEMENTATION PLAN

NTS:

NO.	DATE	REVISION	BY
1	9/10/2025	ISSUED FOR REVIEW	NJ

INF ASSOCIATES ENERGY SOLUTIONS
147 3RD AVENUE
10TH FLOOR, SUITE #1001
NEW YORK, NY 10073
WWW.INFASSOCIATES.COM

I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of New York.

License # _____ Expiration Date: _____

EVSE - DETAILS SHEET (2 OF 2)

BREWSTER CSD
50 FOGGINTOWN ROAD
BREWSTER, NY 10509

PROJECT:	BREWSTER CSD
DESIGNED:	NJ
DRAWN:	NJ
CHECKED:	AC
DATE:	09/10/2025
SCALE:	AS STATED
DRAWING:	E-1



LEGEND	
□	60KW DUAL PORT DCFC
○	120KW DUAL PORT DCFC
△	40KW DUAL PORT DCFC
▭▭	SWITCHGEAR/ELECTRICAL EQUIPMENT
◇	UTILITY TRANSFORMER
– – –	SOIL TRENCHED CONDUIT
———	ASPHALT TRENCHED CONDUIT

CHARGER TRENCH LAYOUT - (ALL PHASES)

NTS

NO.	DATE	REVISION	BY
1	9/10/2025	ISSUED FOR REVIEW	NJ

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ENERGY SOLUTIONS
247 3RD AVENUE
10TH FL, SUITE #1001
NEW YORK, NY 10073
WWW.NFASSOCIATES.COM

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License #_____ Expiration Date: _____

EVSE - SITE PLAN

BREWSTER CSD
50 FOGGINTOWN ROAD
BREWSTER, NY 10509

PROJECT:	BREWSTER CSD
DESIGNED:	NJ
DRAWN:	NJ
CHECKED:	AC
DATE:	09/10/2025
SCALE:	AS STATED
DRAWING:	E-2



LEGEND	
□	60KW DUAL PORT DCFC
○	120KW DUAL PORT DCFC
△	40KW DUAL PORT DCFC
▭▭	SWITCHGEAR/ELECTRICAL EQUIPMENT
◇	UTILITY TRANSFORMER
– · –	SOIL TRENCHED CONDUIT
——	ASPHALT TRENCHED CONDUIT

CHARGER TRENCH LAYOUT - (PHASE 1)

NTS

NO.	DATE	REVISION	BY
1	9/10/2025	ISSUED FOR REVIEW	NJ

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ENERGY SOLUTIONS
147 3RD AVENUE
10TH FL, SUITE #1001
NEW YORK, NY 10073
WWW.NFASSOCIATES.COM

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License #_____ Expiration Date: _____

EVSE - SITE PLAN

BREWSTER CSD
50 FOGGINTOWN ROAD
BREWSTER, NY 10509

PROJECT:	BREWSTER CSD
DESIGNED:	NJ
DRAWN:	NJ
CHECKED:	AC
DATE:	09/10/2025
SCALE:	AS STATED
DRAWING:	E-2.1



LEGEND	
□	60KW DUAL PORT DCFC
○	120KW DUAL PORT DCFC
△	40KW DUAL PORT DCFC
▭▭	SWITCHGEAR/ELECTRICAL EQUIPMENT
◇	UTILITY TRANSFORMER
– – –	SOIL TRENCHED CONDUIT
———	ASPHALT TRENCHED CONDUIT

CHARGER TRENCH LAYOUT - (PHASE 2)

NTS

NO.	DATE	REVISION	BY
1	9/10/2025	ISSUED FOR REVIEW	NJ

INF ASSOCIATES ENERGY SOLUTIONS
147 3RD AVENUE
10TH FL, SUITE #1001
NEW YORK, NY 10073
WWW.INFASSOCIATES.COM

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License #_____ Expiration Date: _____

EVSE - SITE PLAN

BREWSTER CSD
50 FOGGINTOWN ROAD
BREWSTER, NY 10509

PROJECT:	BREWSTER CSD
DESIGNED:	NJ
DRAWN:	NJ
CHECKED:	AC
DATE:	09/10/2025
SCALE:	AS STATED
DRAWING:	E-2.2



LEGEND	
□	60KW DUAL PORT DCFC
○	120KW DUAL PORT DCFC
△	40KW DUAL PORT DCFC
▭▭	SWITCHGEAR/ELECTRICAL EQUIPMENT
◇	UTILITY TRANSFORMER
- - -	SOIL TRENCHED CONDUIT
———	ASPHALT TRENCHED CONDUIT

CHARGER TRENCH LAYOUT - (PHASE 3)

NTS

NO.	DATE	REVISION	BY
1	9/10/2025	ISSUED FOR REVIEW	NJ

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ENERGY SOLUTIONS
247 3RD AVENUE
10TH FL, SUITE #1001
NEW YORK, NY 10073
WWW.NFASSOCIATES.COM

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License #_____ Expiration Date: _____

EVSE - SITE PLAN

BREWSTER CSD
50 FOGGINTOWN ROAD
BREWSTER, NY 10509

PROJECT:	BREWSTER CSD
DESIGNED:	NJ
DRAWN:	NJ
CHECKED:	AC
DATE:	09/10/2025
SCALE:	AS STATED
DRAWING:	E-2.3



LEGEND	
□	60KW DUAL PORT DCFC
○	120KW DUAL PORT DCFC
△	40KW DUAL PORT DCFC
▭▭	SWITCHGEAR/ELECTRICAL EQUIPMENT
◇	UTILITY TRANSFORMER
- - -	SOIL TRENCHED CONDUIT
———	ASPHALT TRENCHED CONDUIT

CHARGER TRENCH LAYOUT - (PHASE 4)

NTS

NO.	DATE	REVISION	BY
1	9/10/2025	ISSUED FOR REVIEW	NJ

ASSOCIATES ENERGY SOLUTIONS
147 - 35D AVENUE
10TH FL., SUITE #1001
WHITE PLAINS, NY 10573
WWW.INFASSOCIATES.COM

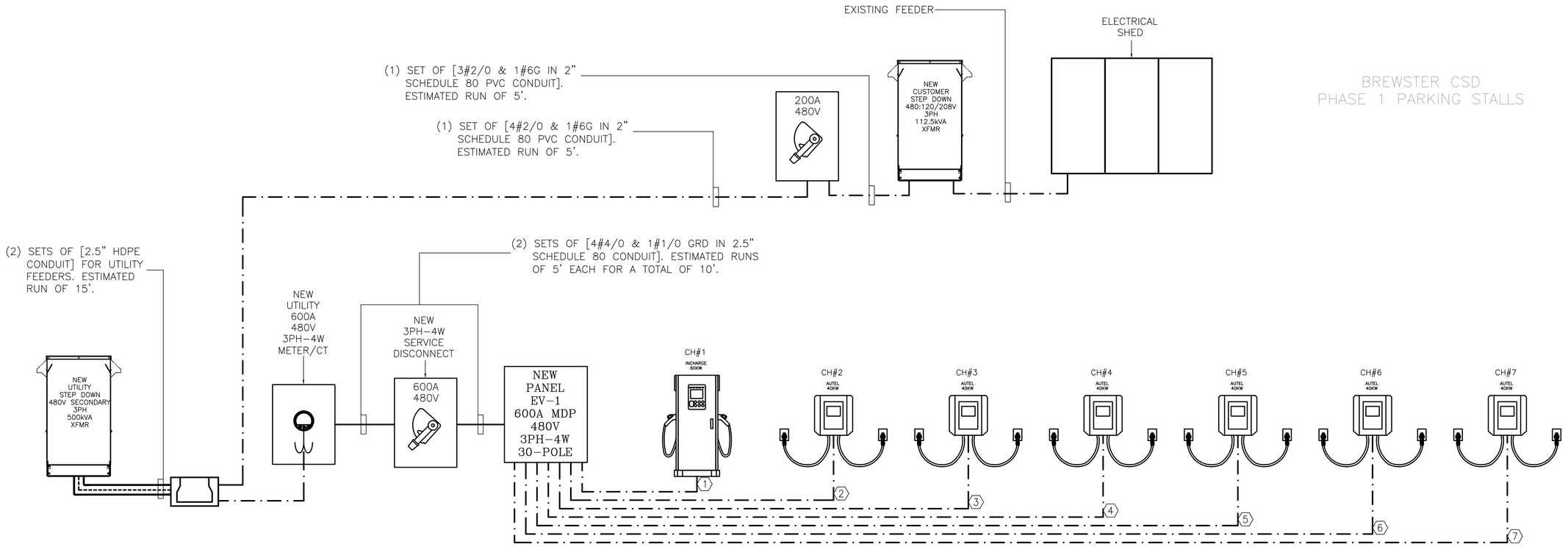
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License #_____ Expiration Date: _____

EVSE - SITE PLAN

BREWSTER CSD
50 FOGGINTOWN ROAD
BREWSTER, NY 10509

PROJECT:	BREWSTER CSD
DESIGNED:	NJ
DRAWN:	NJ
CHECKED:	AC
DATE:	09/10/2025
SCALE:	AS STATED
DRAWING:	E-2.4



ELECTRICAL RISER DIAGRAM

NOT TO SCALE

NOTES:

1. CONTRACTOR SHALL PERFORM ALL WORK IN ACCORDANCE WITH NATIONAL GRID RULES & REGULATIONS.
2. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE AND ALL APPLICABLE CODES.
3. GROUNDING CONDUCTORS AND BONDING JUMPERS SHALL BE CONNECTED BY EXOTHERMIC WELDING OR LISTED PRESSURE CONNECTORS (COMPRESSION TYPE).
4. CONTRACTOR IS RESPONSIBLE FOR PATCHING HOLES FROM THE REMOVAL PROCESS, PATCHED TO MATCH EXISTING CONSTRUCTION.
5. CONTRACTOR SHALL INSTALL (6) DUAL PORT PEDESTAL MOUNTED EV CHARGERS MODEL AUTEL DC COMPACT 40KW.
6. CONTRACTOR SHALL INSTALL (1) DUAL PORT PEDESTAL MOUNTED EV CHARGERS MODEL INCHARGE ICE-60 60KW.

ELECTRICAL NOTES:

1. CONTRACTOR SHALL INSTALL A NEW 600A 480V 3PH-4W NEMA3R DISCONNECT.
2. CONTRACTOR SHALL INSTALL A NEW 200A 480V 3PH-4W NEMA3R DISCONNECT.
3. CONTRACTOR SHALL INSTALL A NEW 600A 480V 3PH-4W 30-POLE MCB NEMA3R PANEL "EV-1".
4. CONTRACTOR SHALL INSTALL (1) 100A 3-POLE 480V CIRCUIT BREAKER IN "EV-1" TO FEED 60KW CHARGER
5. CONTRACTOR SHALL INSTALL (6) 70A 3-POLE 480V CIRCUIT BREAKERS IN "EV-1" TO FEED 40KW CHARGERS
6. CONTRACTOR SHALL PROVIDE & INSTALL CONCRETE BOLLARDS IN FRONT OF ALL NEW ELECTRICAL EQUIPMENT.
7. CONTRACTOR SHALL PROVIDE & INSTALL SIGNAGE & CONCRETE BOLLARDS IN FRONT OF CHARGING STATIONS.

PANEL: "EV-1" | 480 VOLTS, 3 PHASE, 4 WIRE | MAIN BUS 600 AMPS
LOCATION: OUTDOOR | MOUNTING : ■ SURFACE ☐ FLUSH | MAIN BRK 600 AMPS 3 P
BUILDING: 125 CORDELL ROAD | COPPER BUS ■ ALUMINUM BUS ☐ | NEUTRAL – AIC –
FED FROM: 600A SERVICE DISCONNECT | ISOLATED GROUND BUS ☐ | ☐ LUGS ONLY
FEEDER SIZE: 2 SETS [4#4/0 & 1#1/0 GRD IN 2.5"C] | GROUND BUS ■ * SHUNT TRIP BRKR. | FEED: ■ TOP ☐ BOTTOM

CKT. NO.	TRIP AMPS	DESCRIPTION OF LOAD	LOAD (KVA)	PER PHASE (KVA) A	B	C	LOAD (KVA)	DESCRIPTION OF LOAD	TRIP AMPS	CKT. NO.
1	100	EV CHARGER #1	–	–			–	EV CHARGER #2	70	2
3			–		–		–			4
5	3P	3#2 & 1#6GRD – 1-1/2"C	–			–	–	3#4 & 1#8GRD – 1-1/2"C	3P	6
7	70	EV CHARGER #3	–	–			–	EV CHARGER #4	70	8
9			–		–		–			10
11	3P	3#4 & 1#8GRD – 1-1/2"C	–			–	–	3#4 & 1#8GRD – 1-1/2"C	3P	12
13	70	EV CHARGER #5	–	–			–	EV CHARGER #6	70	14
15			–		–		–			16
17	3P	3#4 & 1#8GRD – 1-1/2"C	–			–	–	3#4 & 1#8GRD – 1-1/2"C	3P	18
19	70	EV CHARGER #7	–	–			–	SPACE	–	20
21			–		–		–	SPACE	–	22
23	3P	3#4 & 1#8GRD – 1-1/2"C	–			–	–	SPACE	–	24
25	–	SPACE	–	–			–	SPACE	–	26
27	–	SPACE	–		–		–	SPACE	–	28
29	–	SPACE	–			–	–	SPACE	–	30

ELECTRICAL KEY NOTES

1. CONTRACTOR SHALL RUN 3#2 & 1#6GRD IN A 1.5" SCHEDULE 80 PVC CONDUIT TRENCHED FROM PANEL 'EV-1' CKT'S #1,3,5 TO CHARGER #1. ESTIMATED 50' RUN.
2. CONTRACTOR SHALL RUN 3#4 & 1#8GRD IN A 1.5" SCHEDULE 80 PVC CONDUIT TRENCHED FROM PANEL 'EV-1' CKT'S #2,4,6 TO CHARGER #2. ESTIMATED 70' RUN.
3. CONTRACTOR SHALL RUN 3#4 & 1#8GRD IN A 1.5" SCHEDULE 80 PVC CONDUIT TRENCHED FROM PANEL 'EV-1' CKT'S #7,9,11 TO CHARGER #3. ESTIMATED 90' RUN.
4. CONTRACTOR SHALL RUN 3#4 & 1#8GRD IN A 1.5" SCHEDULE 80 PVC CONDUIT TRENCHED FROM PANEL 'EV-1' CKT'S #8,10,12 TO CHARGER #4. ESTIMATED 40' RUN.
5. CONTRACTOR SHALL RUN 3#4 & 1#8GRD IN A 1.5" SCHEDULE 80 PVC CONDUIT TRENCHED FROM PANEL 'EV-1' CKT'S #13,15,17 TO CHARGER #5. ESTIMATED 64' RUN.
6. CONTRACTOR SHALL RUN 3#4 & 1#8GRD IN A 1.5" SCHEDULE 80 PVC CONDUIT TRENCHED FROM PANEL 'EV-1' CKT'S #14,16,18 TO CHARGER #6. ESTIMATED 88' RUN.
7. CONTRACTOR SHALL RUN 3#4 & 1#8GRD IN A 1.5" SCHEDULE 80 PVC CONDUIT TRENCHED FROM PANEL 'EV-1' CKT'S #19,21,23 TO CHARGER #7. ESTIMATED 112' RUN.

EVSE - ONE-LINE DIAGRAM (PHASE 1)

NTS:

NO.	DATE	REVISION	BY
1	6/18/2025	ISSUED FOR PRICING	NJ
2	7/14/2025	CHARGERS REVISED	NJ
3	7/29/2025	SERVICE SIZE REVISED	NJ
4	9/12/2025	EQUIPMENT REVISED	NJ

INF ASSOCIATES ENERGY SOLUTIONS
147 - 35D AVENUE
10TH FL. SUITE #1001
NEW YORK, NY 10077
WWW.INFASSOCIATES.COM

I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of New York.

License # _____ Expiration Date: _____

EVSE - ONE LINE DIAGRAM

BREWSTER CSD
50 FOGGINTOWN ROAD
BREWSTER, NY 10509

PROJECT:	BREWSTER CSD
DESIGNED:	NJ
DRAWN:	NJ
CHECKED:	AC
DATE:	09/12/2025
SCALE:	AS STATED
DRAWING:	E-2

Priority District?	No
Discount Rate	6%
Escalation Rate	2%

Annual Cash Flows

General											
Year	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Phase	0	1	1	2.1	2.1	2.2	2.2	3.1	3.1	3.2	4
ESB in Fleet	0	14	14	34	34	54	54	73	73	81	91
ICE in Fleet	91	77	77	57	57	37	37	18	18	10	0

CapEx											
Vehicle Costs											
Total Vehicle Costs w/o Incentives	$ -	$ 5,457,000	$ -	$ 8,383,543	$ -	$ 8,943,055	$ -	$ 8,586,425	$ -	$ 3,107,241	$ 4,083,631
Total Vehicle Costs w/ Incentives	$ -	$ 4,167,000	$ -	$ 7,060,543	$ -	$ 7,620,055	$ -	$ 7,263,425	$ -	$ 2,048,241	$ 3,057,631
Infrastructure Costs											
Cost of 40 kW Dual Port	$ 35,000	$ 35,700	$ 36,414	$ 37,142	$ 37,885	$ 38,643	$ 39,416	$ 40,204	$ 41,008	$ 41,828	$ 42,665
Cost of 60 kW Dual Port	$ 45,000	$ 45,900	$ 46,818	$ 47,754	$ 48,709	$ 49,684	$ 50,677	$ 51,691	$ 52,725	$ 53,779	$ 54,855
Cost of 120 kW Dual Port	$ 80,000	$ 81,600	$ 83,232	$ 84,897	$ 86,595	$ 88,326	$ 90,093	$ 91,895	$ 93,733	$ 95,607	$ 97,520
Qty of 40 kW Dual Port	0	6	0	0	0	0	0	0	0	0	0
Qty of 60 kW Dual Port	0	1	0	10	0	10	0	10	0	4	0
Qty of 120 kW Dual Port	0	0	0	0	0	0	0	0	0	0	5
Total Charger Cost	***$ -***	***$ 260,100***	***$ -***	***$ 477,544***	***$ -***	***$ 496,836***	***$ -***	***$ 516,909***	***$ -***	***$ 215,117***	***$ 487,598***
NYSBIP Charger Grant	$ -	$ (55,000)	$ -	$ (55,000)	$ -	$ (55,000)	$ -	$ (55,000)	$ -	$ (55,000)	$ (55,000)
NYSBIP Eligible Install Costs	$ -	$ 160,225	$ -	$ 841,650	$ -	$ 97,405	$ -	$ 533,770	$ -	$ 46,080	$ 46,275
NYSBIP **Ineligible** Install Costs (Permitting, PM, etc)	$ -	$ 67,585	$ -	$ 385,030	$ -	$ 49,300	$ -	$ 240,330	$ -	$ 20,010	$ 21,135
Total NYSBIP Amount	$ -	$ (420,325)	$ -	$ (1,100,000)	$ -	$ (594,241)	$ -	$ (1,045,000)	$ -	$ (261,197)	$ (533,873)
NYSEG Customer-Side MakeReady Funding	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Cost of Utility Upgrades*	$ -	$ 60,000	$ -	$ 2,640,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
NYSEG Utility-Side MakeReady Funding	$ -	$ (30,000)	$ -	$ (1,320,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Infrastructure Costs w/o Incentives	$ -	$ 547,910	$ -	$ 4,344,224	$ -	$ 643,541	$ -	$ 1,291,009	$ -	$ 281,207	$ 555,008
Total Infrastructure Costs w/ Incentives	$ -	$ 97,585	$ -	$ 1,924,224	$ -	$ 49,300	$ -	$ 246,009	$ -	$ 20,010	$ 21,135
Total CapEx w/o Incentives	$ -	$ 6,004,910	$ -	$ 12,727,767	$ -	$ 9,586,596	$ -	$ 9,877,434	$ -	$ 3,388,447	$ 4,638,639
Total CapEx w/ incentives	$ -	$ 4,264,585	$ -	$ 8,984,767	$ -	$ 7,669,355	$ -	$ 7,509,434	$ -	$ 2,068,251	$ 3,078,766

Priority District?	No
Discount Rate	6%
Escalation Rate	2%

Annual Cash Flows

General											
Year	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Phase	0	1	1	2.1	2.1	2.2	2.2	3.1	3.1	3.2	4
ESB in Fleet	0	14	14	34	34	54	54	73	73	81	91
ICE in Fleet	91	77	77	57	57	37	37	18	18	10	0

ESB Fleet OpEx											
ESB Fleet Energy Costs Per Year											
Utility Energy Rate ($/kWh)	$0.00	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04
Utility Demand Rate ($/kW)	$ -	$ 19.65	$ 19.65	$ 16.17	$ 16.17	$ 16.17	$ 16.17	$ 15.44	$ 15.44	$ 15.44	$ 15.34
Months Per Year	10	10	10	10	10	10	10	10	10	10	10
Daily Peak Load (kW)	0	84.2	84.2	453.9	453.9	984.0	984.0	1518.6	1518.6	1658.4	2188.1
ESB Miles Per Day	0	199	199	692	692	1291	1291	2224	2224	2874	3993
Days Per year	180	180	180	180	180	180	180	180	180	180	180
Cumulative Miles Per Year	-	35,820	35,820	124,560	124,560	232,380	232,380	400,320	400,320	517,320	718,740
kWh / Mile Efficiency	0	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Cost Per Mile	0	0.50	0.51	0.63	0.63	0.73	0.73	0.63	0.6	0.54	0.52
Annual Energy Cost Calc	$ -	$ 18,060.89	$ 18,091.15	$ 78,872.03	$ 78,981.51	$ 169,739.60	$ 169,952.10	$ 253,507.14	$ 253,896	$ 281,652.49	$ 371,930.91
ESB Fleet Maintenance Costs per Year											
ESB Maintenance Per Mile*	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.06
Charger Maintenance Per Mile*	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.05	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06	$ 0.06
ESB Miles Per Day	-	199	199	692	692	1,291	1,291	2,224	2,224	2,874	3,993
Days Per Year	180	180	180	180	180	180	180	180	180	180	180
Cumulative Miles Per Year	-	35,820	35,820	124,560	124,560	232,380	232,380	400,320	400,320	517,320	718,740
Annual Maintenance Cost	$ -	$ 3,507	$ 3,578	$ 12,690	$ 12,943	$ 24,630	$ 25,123	$ 44,145	$ 45,028	$ 59,352	$ 84,109
Software Costs per year											
Software Fee per Port*	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000
Number of ports	$ -	$ 14	$ 14	$ 34	$ 34	$ 54	$ 54	$ 74	$ 74	$ 82	$ 92
Annual Software Cost	$ -	$ 14,000	$ 14,000	$ 34,000	$ 34,000	$ 54,000	$ 54,000	$ 74,000	$ 74,000	$ 82,000	$ 92,000
Total ESB OpEx	**$ -**	**$ 35,568**	**$ 35,669**	**$ 125,562**	**$ 125,925**	**$ 248,370**	**$ 249,075**	**$ 371,652**	**$ 372,923**	**$ 423,004**	**$ 548,040**

Priority District?	No
Discount Rate	6%
Escalation Rate	2%

Annual Cash Flows

General											
Year	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Phase	0	1	1	2.1	2.1	2.2	2.2	3.1	3.1	3.2	4
ESB in Fleet	0	14	14	34	34	54	54	73	73	81	91
ICE in Fleet	91	77	77	57	57	37	37	18	18	10	0

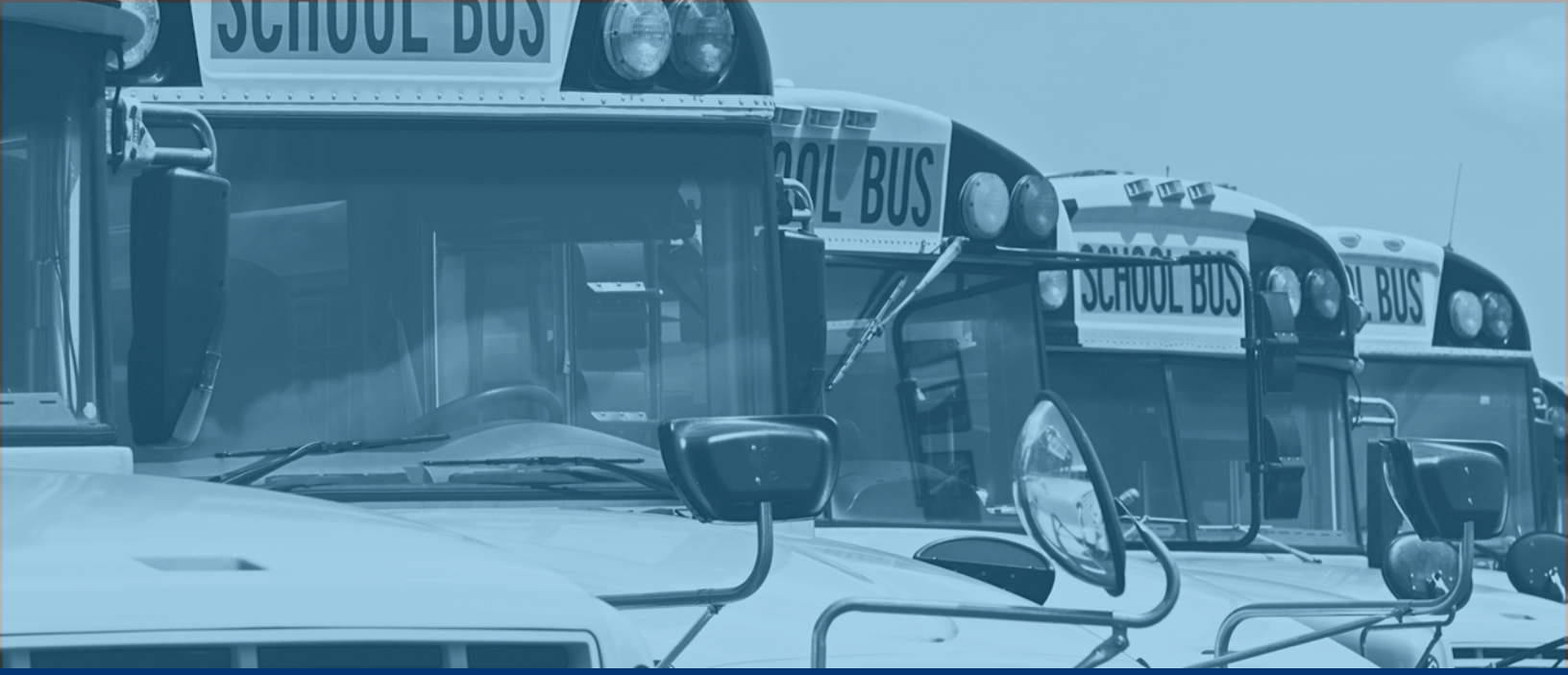
CapEx											
Total Vehicle Costs w/o Incentives	$ -	$ 5,457,000	$ -	$ 8,383,543	$ -	$ 8,943,055	$ -	$ 8,586,425	$ -	$ 3,107,241	$ 4,083,631
Total Vehicle Costs w/ Incentives	$ -	$ 4,167,000	$ -	$ 7,060,543	$ -	$ 7,620,055	$ -	$ 7,263,425	$ -	$ 2,048,241	$ 3,057,631
Total Infrastructure Costs w/o Incentives	$ -	$ 547,910	$ -	$ 4,344,224	$ -	$ 643,541	$ -	$ 1,291,009	$ -	$ 281,207	$ 555,008
Total Infrastructure Costs w/ Incentives	$ -	$ 97,585	$ -	$ 1,924,224	$ -	$ 49,300	$ -	$ 246,009	$ -	$ 20,010	$ 21,135
Total CapEx w/o Incentives	$ -	$ 6,004,910	$ -	$ 12,727,767	$ -	$ 9,586,596	$ -	$ 9,877,434	$ -	$ 3,388,447	$ 4,638,639
Total CapEx w/ incentives	$ -	$ 4,264,585	$ -	$ 8,984,767	$ -	$ 7,669,355	$ -	$ 7,509,434	$ -	$ 2,068,251	$ 3,078,766

ESB Fleet OpEx											
Annual Energy Cost	$ -	$ 18,060.89	$ 18,091.15	$ 78,872.03	$ 78,981.51	$ 169,739.60	$ 169,952.10	$ 253,507.14	$ 253,896	$ 281,652.49	$ 371,930.91
Annual Maintenance Cost	$ -	$ 3,507	$ 3,578	$ 12,690	$ 12,943	$ 24,630	$ 25,123	$ 44,145	$ 45,028	$ 59,352	$ 84,109
Annual Software Cost	$ -	$ 14,000	$ 14,000	$ 34,000	$ 34,000	$ 54,000	$ 54,000	$ 74,000	$ 74,000	$ 82,000	$ 92,000
Total ESB OpEx	**$ -**	**$ 35,568**	**$ 35,669**	**$ 125,562**	**$ 125,925**	**$ 248,370**	**$ 249,075**	**$ 371,652**	**$ 372,923**	**$ 423,004**	**$ 548,040**

Phased Cost Projections

General						
Year	**2026-2027**	**2028-2029**	**2030-2031**	**2032-2033**	**2034**	**2035**
Phase	**1**	**2.1**	**2.2**	**3.1**	**3.2**	**4**
ESB In Fleet	14	34	54	73	81	91
ICE In Fleet	77	57	37	18	10	0

CapEx & OpEx						
CapEx Without Incentives	$ 6,004,910	$ 12,727,767	$ 9,586,596	$ 9,877,434	$ 3,388,447	$ 4,638,639
CapEx With Incentives	$ 4,264,585	$ 8,984,767	$ 7,669,355	$ 7,509,434	$ 2,068,251	$ 3,078,766
OpEx	$ 71,237	$ 251,487	$ 497,445	$ 744,575	$ 423,004	$ 548,040
Total Without Incentives	$ 6,076,147	$ 12,979,253	$ 10,084,041	$ 10,622,009	$ 3,811,451	$ 5,186,679
Total With Incentives	$ 4,335,822	$ 9,236,253	$ 8,166,800	$ 8,254,009	$ 2,491,255	$ 3,626,807
Cumulative Without Incentives	$ 6,076,147	$ 19,055,401	$ 29,139,442	$ 39,761,451	$ 43,572,902	$ 48,759,582
Cumulative With Incentives	$ 4,335,822	$ 13,572,076	$ 21,738,875	$ 29,992,884	$ 32,484,139	$ 36,110,946



Electric School Bus Guidebook

Guide 10: Workforce T&D

(Training and Development)

NEW YORK STATE | NYSERDA



Proactive workforce training can help ensure a seamless transition to operating ESBs.

This chapter discusses instruction programs available to current staff as well as workforce development programs focused on bringing new employees into the industry.

This chapter of the *Electric School Bus Guidebook* answers these questions:

- What trainings are available for school districts adopting ESBs?
- What workforce development support efforts are underway?
- What can a school district or private fleet operator do now to begin planning for workforce changes?

Key Activities

Initial actions you can take after reading this chapter include:

- Begin assessing the impacts of ESB adoption on your current workforce.
- Talk with your dealer and/or equipment manufacturer about the training they offer with equipment purchases.
- Learn about current and future training opportunities in New York State.
- Explore additional training options.

Workforce Development Objectives

As more school districts and school bus fleet operators use electric school buses (ESBs) they will need to train their staff in how to use and maintain ESBs as well as charger troubleshooting and diagnostics.

The electric vehicle industry, government agencies, community colleges, and other stakeholders are currently working to address two types of training needs:

- Upskilling existing employees by providing existing staff with the knowledge, tools, and resources they need to properly operate, repair and maintain ESBs and chargers.
- Developing programs to offer credit and certifications for people seeking work in the ESB sector.

Addressing workforce development in these two areas involves collaboration between school districts, private fleet operators, ESB and charger manufacturers and dealers, vocational schools and community colleges, training centers, and State agencies.

New York Workforce Needs Assessment

The Workforce Development Institute (WDI), a non-profit focused on improving access to well-paying employment opportunities in clean energy, conducted a NYS workforce needs assessment for the implementation of ESBs. The assessment focused on new and existing jobs supporting ESBs, the impact that the technological transition will have on staff across the industry and recommendations to promote a smooth deployment process.

Through research and stakeholder interviews WDI identified skill gaps and training needs for staff operating and maintaining ESBs. Employment data from 2021 showed that over 50,000 workers directly support the school bus industry across the State. WDI identifies five main areas with workforce implications:

- Motor and drive components
- Driver training
- Maintenance needs
- Operations
- Fuel system

Within each category, WDI identifies specific operational and maintenance changes associated with ESBs that operators and mechanics will need to understand and offers recommendations to support a smooth and equitable ESB transition. WDI is also developing training modules on the basics of electrical systems, electric buses, chargers, and safety.







Essential ESB Workforce Trainings

Driver Training

Because electric school buses have operating systems and processes that differ from typical gasoline and diesel buses, driver training is an important component of ESB adoption. Training on how to operate ESBs safely and efficiently is often provided by the dealer or manufacturer ahead of, or at the time of, delivery. The depth and breadth of this training can vary significantly from one dealer or manufacturer to the next, so it is important to communicate your specific needs and expectations upfront regarding number of employees that require training, the duration of training, and specific local concerns such as extremely hilly terrain.

You should develop a plan that identifies not only who will receive the initial training upon delivery but also how ongoing training will occur (classroom, virtual training, or on-road). This could follow a “train the trainer” model conducted by a school district representative or via ongoing training sessions from the manufacturer/dealer. It can also be useful to reach out to nearby school districts or school bus contractors who already operate electric buses and inquire about scheduling a test-drive or ride-along event.

At a minimum, you should ensure that your drivers and fleet managers receive training on the following topics:

- The basic functions of ESBs.
- How to use regenerative braking for maximum efficiency and range.
- Other ways to optimize battery range, especially during cold or inclement weather.
- How to charge the bus and read the battery gauge.
- What to do in an emergency such as a battery leak, vehicle fire, or charge depletion.

ESB Maintenance Training

Currently, the majority of ESB maintenance involves the electric drivetrain, which is managed by the dealer and covered under the bus’s warranty. However, some types of maintenance and repair may require a separate maintenance contract with the dealer. When an ESB requires maintenance attention, a dealer may send a mechanic to your bus depot to evaluate and/or perform the maintenance. When possible, your in-house mechanics should shadow expert ESB mechanics during the maintenance to learn best practices. If the bus is taken offsite for maintenance, you should follow up to better understand the specific maintenance performed.

ESB maintenance not related to the electric drivetrain is similar to that done for traditional gasoline or diesel buses (e.g., brake changes and tire replacement and balancing). The frequency for monitoring and servicing these components may be different for electric vehicles (i.e., more frequent tire replacements but less frequent brake servicing) so it is important to understand the manufacturer’s recommended service guidelines. These can usually be completed by current technicians without additional training.

Charger Maintenance Training

ESB charger repairs are typically handled by contracted vendors. However, there are certain routine maintenance checks that should be carried out by the drivers and/or other facilities staff who interact with the chargers daily to ensure optimal performance and user safety. Check Guide 8: Charger Operations and Maintenance for details.

Workforce Development Support

Hudson Valley Community College - Electric and Autonomous Vehicles Degree

Hudson Valley Community College (HVCC) in Troy, NY, offers an Electric and Autonomous Vehicle degree that provides enrolled students with the training necessary to become vehicle technicians to support the transition to ESBs. This program covers general automotive repair, with specific development of the skills necessary to recognize, diagnose, and address hybrid and electric vehicle issues. Required courses include Engines, Automotive Electricity, Fuel Systems, Passenger Car Diagnosis, Advanced Hybrid and Electric Cars, Vehicle Data Security, among others. Full time students can complete the curriculum in four terms at a cost of slightly over $10,000 for NY residents, based on current per-term costs. Financial aid may be available upon application and HVCC participates in US Veterans Affairs educational programs.

Empire State Development Employee Training Incentive Program

The Employee Training Incentive Program (ETIP) is a $5 million per year incentive program available to New York State employers that provides tax credits to businesses that provide employee training or internships.

ETIP provides a tax credit of 50% of eligible training costs, up to $10,000 per employee receiving eligible training. To qualify for the ETIP tax credit, businesses must make a significant capital investment resulting in a benefit-cost ratio of at least 10:1 in relation to the eligible training project. Businesses must operate predominantly in a strategic industry based upon the following criteria:

- Potential to create jobs in an economically distressed area
- Shortages of workers trained to work in that industry
- Ability and need to relocate to another state to find qualified workers
- Potential to recruit minorities and women to be trained to work in an industry where they are traditionally underrepresented
- Recent technological advances have created disruption in the industry and significant capital investment is needed to remain competitive

The Internship Program provides a tax credit of 50% of the stipend paid to an intern, up to $3,000 per intern. To qualify, a business must provide training in advanced technology, life sciences, software development or clean energy. Training can be provided to interns who have not previously participated in an eligible internship program, and who are not current or former employees of the business. The business entity must have fewer than 100 employees, and interns cannot displace regular employees. Participation in the internship program cannot last longer than 12 months.

To apply, a business must submit an initial ETIP application to be evaluated and approved by the Empire State Development tax incentive department. If approved, the applicant will receive a conditional certificate of eligibility for training, which allows the applicant to begin the program. Once the training is complete, the applicant submits a final application to receive the tax credit. *Please note that the HVCC Electric and Autonomous Vehicles degree is not eligible for this tax credit.*

Workforce Training Curriculum Development in the Bronx and Beyond

In November 2022, NYSERDA awarded New York School Bus Umbrella Services (NYCSBUS), a non-profit New York City school bus operator, with a New York Clean Transportation Prize grant including funding for the development of an ESB curriculum in partnership with Bronx Community College (BCC). BCC will work with NYCSBUS and their team of consultants to create courses on the operation, safety, and fleet management of ESBs. The proposed project includes the development of 20 hours of curriculum (syllabus, lesson plans, and related materials) consistent with vehicle user manuals and warranty conditions. The online training content will engage current and future bus drivers and technicians and will be available as part of the New York Center of Excellence's free online repository for other educational institutions to adopt and implement. In addition, interested fleet operators can attend technical training at NYCSBUS's Zerega depot.

Next Steps

As you begin to electrify your fleets, integrate training and workforce development considerations into your transition planning process. The State's zero-emission school bus requirements also call for districts and contractors to analyze workforce impacts in an effort to minimize job losses and identify skill gaps early in the transition process. Start by:

- Assessing the impacts of school bus electrification on their existing workforce
- Identifying the need for knowledge and skills expansion
- Coordinating with local ESB dealers and charging vendors to address these needs

These steps will help you outline an approach to workforce development and training planning. See the following Additional Resources section for examples of fleet transition plans that address workforce development needs.

Additional Resources

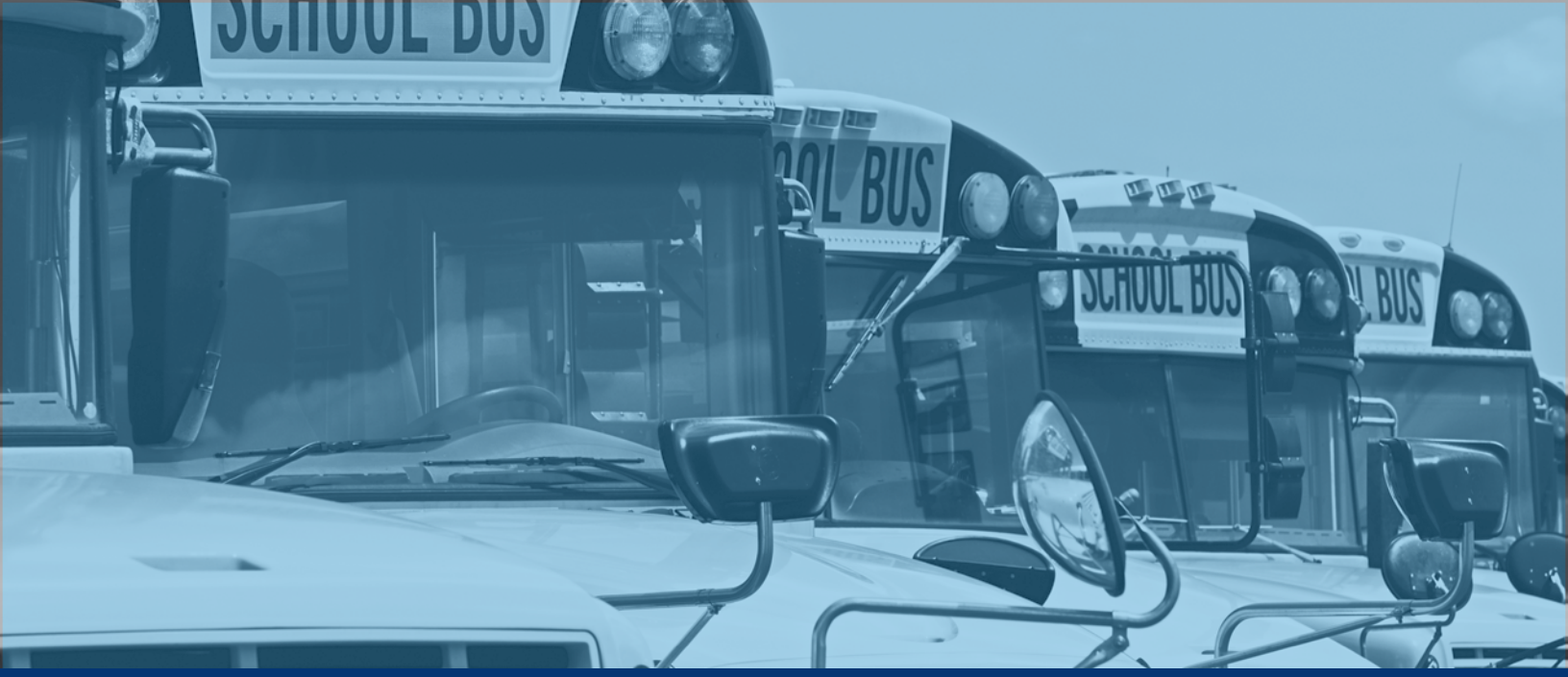
Automotive Service Excellence (ASE) – The National Institute for Automotive Service Excellence provides two levels of EV safety certification, one for general awareness and one for technicians. These certifications are encouraged for staff who will work near EVs or technicians who work directly with EVs, respectively. The cost for each certification is under $50 and these ASE certifications are current for 3 years after issuance.

MTA Zero-Emission Bus Transition Plan – This document is the first step in a dynamic process, a building block to inform the ongoing effort to convert the MTA fleet to zero-emissions. It lays the groundwork for the transition by identifying the challenges and constraints facing the shift to zero-emissions, outlines a strategic approach to overcome them, and lays out a preliminary plan for implementation. It addresses the topic of workforce development and many other areas impacted by the transition to zero-emissions.

National Alternative Fuels Training Consortium (NAFTC) – This training organization develops curricula and disseminates online and in-person training about alternative fuels, alternative fuel vehicles, and advanced technology vehicle education including specific training for EV automotive technician training and first responder training.

SAE International – SAE International, previously the Society of Automotive Engineers, has introduced new online courses that address topics including battery systems and a general overview of hybrid and electric vehicles. Prices range from $345 to $2,499. Courses can be either accessed on-demand or through live, virtual trainings, which range in length from one day to five days. Certificates are available upon completion.

Transit Workforce Center ZEB Workforce Transition Resources - The Transit Workforce Center (TWC) offers online courses on battery electric bus maintenance and technology, and it provides access to a webinar series on battery electric buses, which gives an overview of ESB maintenance, high voltage safety, and battery charging strategies.



Electric School Bus Guidebook

Guide 7: Bus O&M

(Operations & Maintenance)

NEW YORK STATE | NYSERDA



Properly operating and maintaining ESB can maximize performance and reliability.

Electric school bus (ESB) operators and operators of diesel- and gasoline-fueled buses must adhere to the same federal and state safety requirements and follow similar maintenance recommendations. Generally, ESBs require less maintenance yet they require certain care regimens to ensure that they run safely and efficiently throughout their lifetimes.

This chapter of the *Electric School Bus Guidebook* answers these questions:

- What are the key differences between ESBs and diesel- and gasoline-fueled buses that impact operation and maintenance requirements?
- What federal and State operation and maintenance regulations do ESB operators need to follow?
- What are the operation and maintenance cost differences between ESBs and diesel- and gasoline-powered buses?

Key Activities

Initial actions you can take after reading this chapter include:

- Adopt or create an electric school bus pre- and post-trip inspection checklist.
- Speak with your ESB vendor about available operation and maintenance trainings.
- Stay up to date with new State and federal ESB operation and maintenance requirements.

ESB Maintenance

A diesel engine has approximately 2,000 individual parts, while an electric motor contains fewer than 100. With fewer moving parts, there is less routine maintenance needed and fewer major repairs, which decreases the amount of maintenance required over the lifetime of an ESB and can save operators between $4,000–$11,000 per ESB every year.[1] Although ESBs still require coolant, and wiper fluid, they do not use power steering fluid or engine oil. ESBs equipped with hydraulic brakes still require brake fluid. However, ESBs also use regenerative braking that significantly reduces brake wear and associated brake maintenance needs. Regenerative braking works by using the electric motors as a generator to produce electrical power as the vehicle decelerates. Figure 1 shows the primary components of an ESB powertrain.

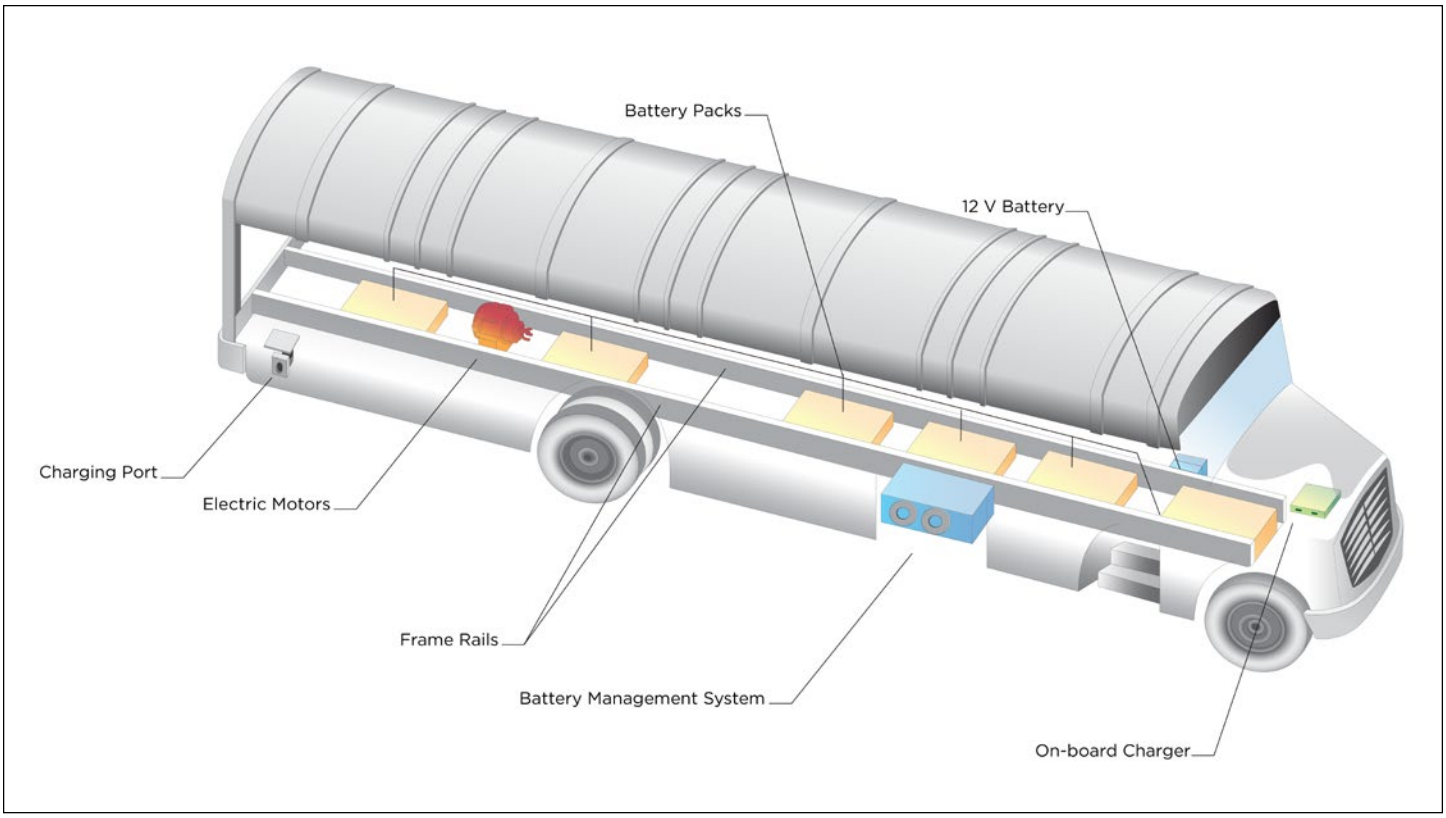


Figure 1: Schematic of an electric school bus

[1] https://afdc.energy.gov/files/u/publication/electric-school-bus-us-market-study-buyers-guide.pdf?da24b3ed9c



New York State Requirements

ESB operators are required to follow all State operation and maintenance requirements to ensure safe vehicle operation. Although the U.S. Department of Transportation's (USDOT) National Highway Traffic Safety Administration (NHTSA) does not regulate school bus use, they recommend that each state develop a comprehensive program for the safe operation of school buses.[2] New York State has several operation and maintenance requirements that must be followed by all ESB operators.

Currently, NYS ESB requirements do not differ from those for diesel and gasoline school buses, although this may change in the future as ESBs are more widely deployed. A brief summary of the requirements is outlined below, and a full list of New York State Department of Transportation (NYSDOT) requirements can be found in N.Y. Comp. Codes R. & Regs. Tit. 17 § 720 - 722.

- **Maintenance Requirements** – School bus operators are required to inspect and repair school buses at set maintenance intervals. The maintenance program should include brake systems, steering mechanisms, and operating lights. Any issues identified must be repaired before the vehicle returns to operation.
- **Daily Inspections** – School bus drivers, who must all maintain a valid Commercial Driver License (CDL) with the necessary passenger endorsements, must conduct daily pre- and post-trip inspection reports. Any defects must be reported and fixed before vehicles are operated. In addition, drivers must review the previous day's reports and adhere to Federal Motor Carrier Safety Administration (FMCSA) safety and operation requirements. The NYSDOT provides CDL drivers with an example vehicle inspection report.
- **Biannual Inspections** – NYSDOT requires school buses to undergo comprehensive maintenance and safety inspections every six months. These inspections are conducted by the State and require a passing grade for legal operation. A full list of inspection criteria can be found in Part 720 of the N.Y. Comp. Codes R. & Regs. Tit. 17 § 720 - 722.

The importance of pre- and post-trip inspection reports

Pre- and post-trip inspection reports are required by New York State to be completed by school bus operators daily. The inspection reports play a critical role in maintaining the safe operation of school buses. Pre-trip inspections help prevent deployment of ESBs with unnoticed damage while post-trip inspections help ensure that ESB operators and mechanics have ample time to repair damaged ESBs before the next use. In combination, these inspection reports can prevent maintenance down time and extend the life of an ESB. Visual inspections should note any leaking fluids or gases, similar to the way a visual inspection of a diesel- or gas-fueled vehicle would be conducted.

[2] https://one.nhtsa.gov/nhtsa/whatsup/tea21/tea21programs/pages/PupilTransportation.htm

General ESB Maintenance

Most maintenance related to electric drivetrains is completed by the manufacturer or dealer. Generally, these types of repairs are covered under the bus's warranty; however, some types of maintenance might require a separate maintenance contract with the manufacturer and/or dealer. A typical manufacturer warranty covers electric drivetrains and batteries for five years or 100,000 miles, though some warranties are longer. Additionally, manufacturers often recommend purchasing additional towing coverage because a typical ESB warranty does not cover the cost of towing an ESB from the depot to the manufacturer's/dealer's repair facility when more extensive work is required. General bus maintenance not related to the electric drivetrain is similar to that for diesel- and gas-fueled buses and may be completed by in-house mechanics without additional training.

When an ESB requires maintenance attention, a manufacturer or dealer might send a mechanic to the bus depot to evaluate and/or perform the maintenance. To the extent possible, in-house mechanics should shadow the visiting mechanic during the length of the maintenance contract to learn best practices for recognizing and responding to maintenance issues.

Maintenance Precautions

Before performing ESB maintenance work that involves potential contact with high-voltage systems, operators need to disengage the battery contactors and wait 15 minutes before performing maintenance. The high-voltage systems on ESBs can cause serious injury if proper safety precautions are not taken. Operators should always refer to the ESB service manuals provided by the manufacturers for model-specific operation and maintenance schedules and guidelines. Please see Guide 9: Safety for more details.

Operational Costs

ESB operational costs include fuel and energy costs and labor costs. Fuel and energy costs depend on ESB battery efficiency, auxiliary electrical loads in addition to vehicle charging, and the rate structure of the electric utility. Labor costs depend on the pay rates for drivers and other support staff, including technicians and the employees responsible for plugging in and/or moving ESBs.

Fuel and Energy Costs

ESBs are, on average, nearly four times more energy efficient than their ICE counterparts.[3] Electricity can also provide greater cost certainty than liquid fuels.[4] Over the past two decades, the average retail price of diesel fuel has seen volatile cost fluctuations (Figure 2) whereas the cost of electricity has maintained a steady and moderate increase of about 4% per year.[5]

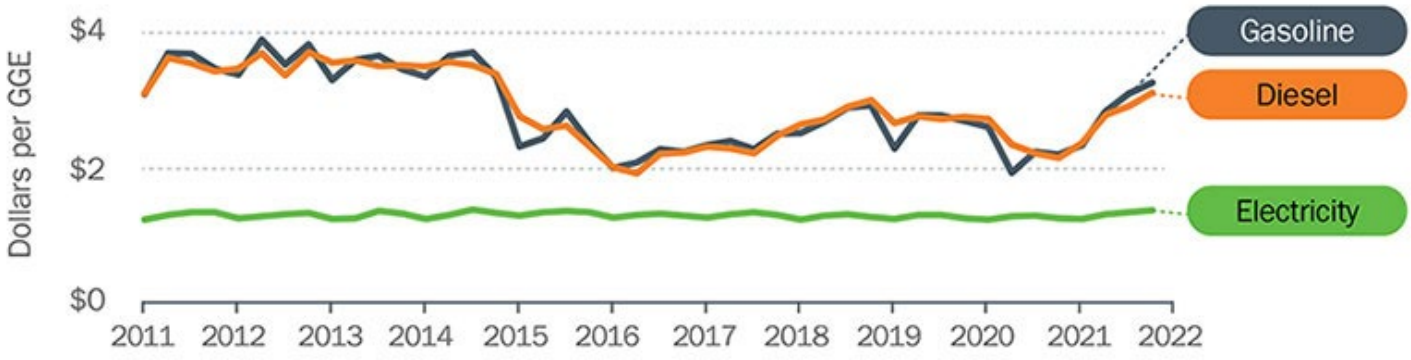


Figure 2: The average retail fuel prices in the United States.

Though electricity costs are not as volatile, electricity demand charges can significantly affect ESB operating costs. Depending on the rate structure set by the electric utility, charging ESBs during peak demand times may have an additional premium cost. To address the barrier to EV adoption created by demand charges, New York State requires investor-owned utilities to create a commercial tariff using alternative rates for EV charging with lower, or even no, demand charge.[6] These alternative rates, which the utilities are introducing in 2024, can significantly decrease the cost of charging for fleets.[7] You should work with your electric utility to understand how these demand charges are structured to avoid paying more than necessary.

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[3] *"Operational Costs"* https://afdc.energy.gov/vehicles/electric_school_buses_p8_m2.html
[4] https://afdc.energy.gov/vehicles/electric_fleets.html
[5] http://www.afdc.energy.gov/fuels/prices.html
[6] https://www.nysenate.gov/legislation/bills/2021/S3929
[7] https://www.utilitydive.com/news/can-used-batteries-be-the-key-to-unlock-ev-charging-profits/504820/



"Smart charging" is an approach that can save bus operators money by reducing peak electricity demand that can lead to high demand charges. Smart charging involves the use of an electric vehicle charge management system, software that is integrated with chargers to manage vehicle charging. A smart charging system optimizes vehicle charging by determining when and how long to charge, based on how much each bus needs to charge, and adjusting the time and rate of charging for each bus to minimize the peak electricity demand. Some chargers may come with charge management systems already installed. If not, you may choose to purchase the software from a third-party vendor or have an outside contractor manage your charging for you.

Federal Training Program

The U.S. Department of Energy's (U.S. DOE) Alternative Fuels Data Center has published an educational resource called Flipping the Switch on Electric School Buses. It includes several modules to educate and train ESB stakeholders on a variety of topics, and it includes a module on how to train drivers and technicians to conduct maintenance on ESBs. The training advises that creating a well-planned training program that incorporates your entire organization will lead to the successful integration of your ESB fleet and that establishing operator familiarity with new vehicles will improve safety, reduce maintenance issues, and reduce range anxiety. Modules of the training include:

Module	Audience	Topics
Electric Vehicle Basics and Safety	Operators, technicians, dispatch personnel, management, training personnel, area first responders	Overview of ESBs, high voltage safety, hazards of EVs, restrictions, and guidance sheets for first responders.
Electric Bus Overview	Operators, technicians, management, training personnel	Electric system orientation, start and shutdown processes, high voltage, and PPE, driving differences including regenerative braking, and dealing with on-road failures.
Charging Infrastructure	Operators, technicians, vehicle support staff, training personnel	Charging station basics, safety, and usage procedures, as well as charger maintenance and repair.
Advanced Technology	Technician, training personnel	Electrically driven components, battery systems, propulsion motor, and electrical systems.

ESB manufacturers and vendors provide service manuals with the sale of their ESBs. Drivers and technicians should familiarize themselves with these manuals to gain a thorough understanding of how to properly maintain their newly purchased ESBs. Dealers should provide familiarization training for technicians and operators at the time of delivery.

Additional Resources

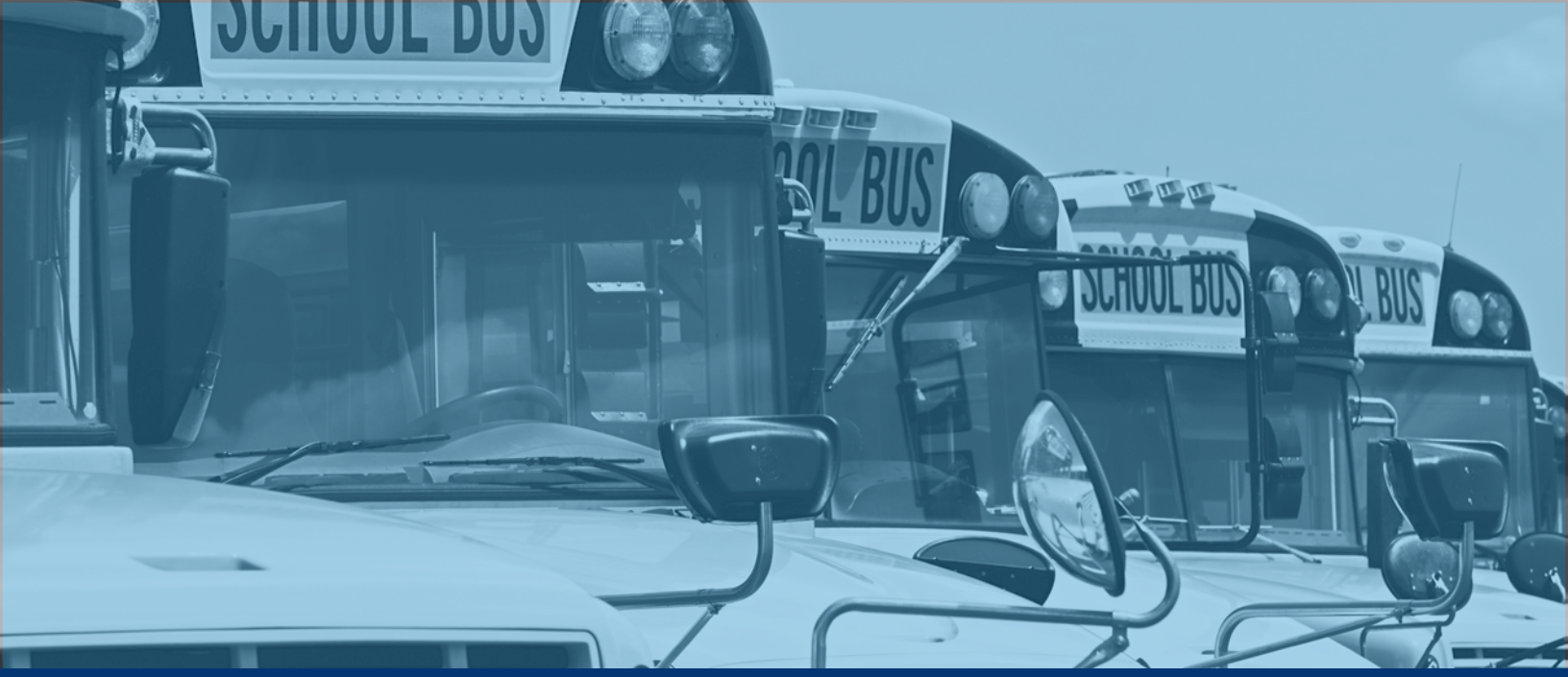
New York State Department of Transportation (NYSDOT) Standard School Bus Safety Inspection – The NYSDOT standard school bus safety inspection guidelines list the criteria that must be met to pass New York State school bus safety inspections.

NYSDOT Bus and Passenger Vehicle Regulations – A compilation of the NYSDOT bus and passenger vehicle safety regulations, school bus and school bus operator requirements, crash reporting requirements, and hours of labor for operators of motor buses.

NYSDOT Bus and Passenger Home Page – The home page for NYSDOT bus operation, safety, and maintenance requirements.

US DOE Electric School Bus Education – The U.S. DOE landing page for electric school bus education materials ranging from electric bus basics to operational consideration including maintenance.

NEW YORK STATE | NYSERDA



Electric School Bus Guidebook

Guide 8: Charger O&M

(Operations & Maintenance)

NEW YORK STATE | NYSERDA



Properly operating and maintaining chargers can ensure safety and reliability.

A charger, for the purpose of this guide, encompasses all the equipment that transfers electricity to recharge the electric school bus's (ESB) battery. This equipment includes the charging station and mounting systems, charging cables, charge management software, and communications hardware. This equipment will be installed at the school bus operator's facility and will require maintenance and repair. Having a plan that clearly describes procedures for charger operations and maintenance (O&M) can greatly increase charger and ESB reliability.

This chapter of the *Electric School Bus Guidebook* answers these questions:

- What should I consider when operating chargers?
- How can I properly maintain chargers?
- What are the options for servicing chargers?

Key Activities

Initial actions you can take after reading this chapter include:

- Create an operations plan for your chargers.
- Create a maintenance plan for your chargers.



Charger Operations

This section summarizes the basics of charger operation and charger system management. You should work with your charger manufacturer and/or third-party charging service provider to develop a charging operations plan. Such a plan will clearly describe step-by-step charging and related safety procedures for bus drivers, facilities staff, and all other personnel involved in ESB charging activities. Consider the elements discussed below when developing your charging operations plan.

Connecting an ESB to a Charger

The most regularly handled charger component is the charger connector, which is the device that is plugged into the bus. Plugging the charger connector into the ESB is not complex, but it is important to ensure that the ESB is in the correct location prior to plugging it in. An ESB that is just a few feet away from the proper location may cause the driver to pull and bend the cable to be able to plug it in. Over time, this will damage the cable and could lead to electric shocks or even contribute to fires.[1] It is important to train drivers on the correct way to connect and disconnect the charger connector to avoid frequent replacement of the connector. Carefully read the charging station operator's manual or ask your dealer for a training session on how to plug and unplug the charger connector from the bus.

Properly unplugging the charger connector from the ESB must be done by following the disconnection instructions. Attempting to unplug the charger while a bus is actively charging can damage the charger connector over time. Refer to the charger's manual for instructions on how to end a charging session early. Once the charger connector is removed, it is imperative that the driver puts it back onto the charging station in the correct spot. Every charging station is different, but just like diesel and gasoline refueling nozzles, they all have a spot for the charger connector when not in use. If the charger connector is left on the ground after the vehicle is unplugged, it will likely get run over and may need to be replaced.



[1] https://energy5.com/ensuring-the-safety-of-electric-vehicle-charging



Figure 1: Charging Station with Bollard Protection

Charger Protection

Different charger models include different cable management methods. Charging cables mounted on reels that retract the cable can be useful so that longer cables will not get run over by school buses or become tripping hazards. Another way to protect charging stations is to install bollards, physical barriers placed between the charging station and parking space (Figure 1). These will help ensure that charging stations are not accidentally damaged by ESBs. Note, however, that bollards slightly increase the space requirements needed for the ESBs. See the Solus Group's EV Fleet Charging for Electric Delivery Vans: Charging Station Considerations for more information on charging station siting considerations.

Charge Management

A third-party service provider can develop and install charge management software to automatically control the charging start and stop times for each ESB in your fleet, helping to minimize charging costs. Such software, which is highly recommended, allows fleets to avoid peak demand charges and delay charging sessions until nighttime, while still plugging vehicles in directly upon return to the depot. If you are using charge management software to charge your ESBs, you will need to provide your charge management provider with several pieces of information including utility billing rate information, ESB route start/end times and dwell times, and ESB battery capacity.

Charger Maintenance

Properly operated chargers will require less frequent maintenance and repair. Each charger manufacturer has recommended preventative maintenance procedures to help prolong charger lifespan. For example, manufacturers will specify a recommended replacement schedule for certain charger components such as power cables and intake and exhaust filters. Fleet managers should also schedule and perform recommended routine maintenance checks on chargers. These checks should include a visual inspection of units for external damage resulting from weather (e.g., corrosion) or vehicles bumping into or running over the charger and cables. Other regular activities should include monitoring for unusual sounds and/or odors coming from power units and fans, and cleaning surfaces of dust and dirt. These checks should be performed on a regular basis, such as monthly inspections.

In addition to preventative maintenance checks, it is important for you to have a plan in place to ensure proper charger repair and reduce charger downtime when operational problems occur. If a charger stops working without warning and no external damage is visible, then the issue could be caused by software, firmware (i.e., permanent software that is programmed to control hardware), or hardware associated with the device. If a charger does not work the first time you plug in a bus, you can troubleshoot by unplugging and plugging the charger back into the bus or turning the power to the charger off and then back on. If the problem persists, contact your charging system service representative to arrange for diagnosis and repair assistance. For fleets whose chargers are operated by in-house staff, contact the equipment manufacturer. For fleets whose chargers are operated by a third-party provider, the provider may be fully responsible for maintaining and repairing chargers.

Extending Charger Warranties and Maintenance

Most charging stations come with a two- to three-year warranty period, but operators should have a maintenance plan in place for the period after the warranty expires. There are four options to provide for extended charger maintenance, summarized below. Regardless of the option selected, repair time for out-of-service chargers will vary based on the nature of the problem, although it may be possible to quickly swap out damaged hardware depending on the vendor.

Charger Company Extended Warranty – Many ESB charging companies offer extended diagnostic, parts, and labor warranties on their equipment. Extended warranties typically last for five years. Under this option it may be possible to bundle warranty costs with ESB purchasing to avoid additional procurement work and capitalize the cost of maintenance. Additionally, extended warranty programs may guarantee a specific level of charger availability, typically expressed as a percentage (e.g., 98% uptime). This can be the least expensive of the extended maintenance plan options, although warranty exclusions may require unexpected out-of-pocket costs and extended repair delays.

Charge Management Provider Warranty – Charge management providers may also offer a service warranty package. This may include in-house diagnostics and external coordination to find parts and third-party service labor.

Maintenance Service Contract – Fleets that do not use "as-a-service" contractors can also purchase third-party charging station "reliability-as-a-service" packages for all major charger brands or from a third-party. Equipment down-time should be particularly low under this option given the focus on reliability. Under a reliability-as-a-service contract, users will typically pay a monthly fee that includes service response within a set time. Maintenance service contracts can cover more repairs than a warranty, including damage from vehicles, snowplows, or other causes, but do not necessarily cover the cost of the parts required to repair equipment.

As-a-Service Contractors – If a district hires an as-a-service contractor for its entire fleet, the contractor may include charging station maintenance in its scope of work. Most or all operational costs are covered under the contract, and can potentially see cost savings by bundling their bus and charger needs.

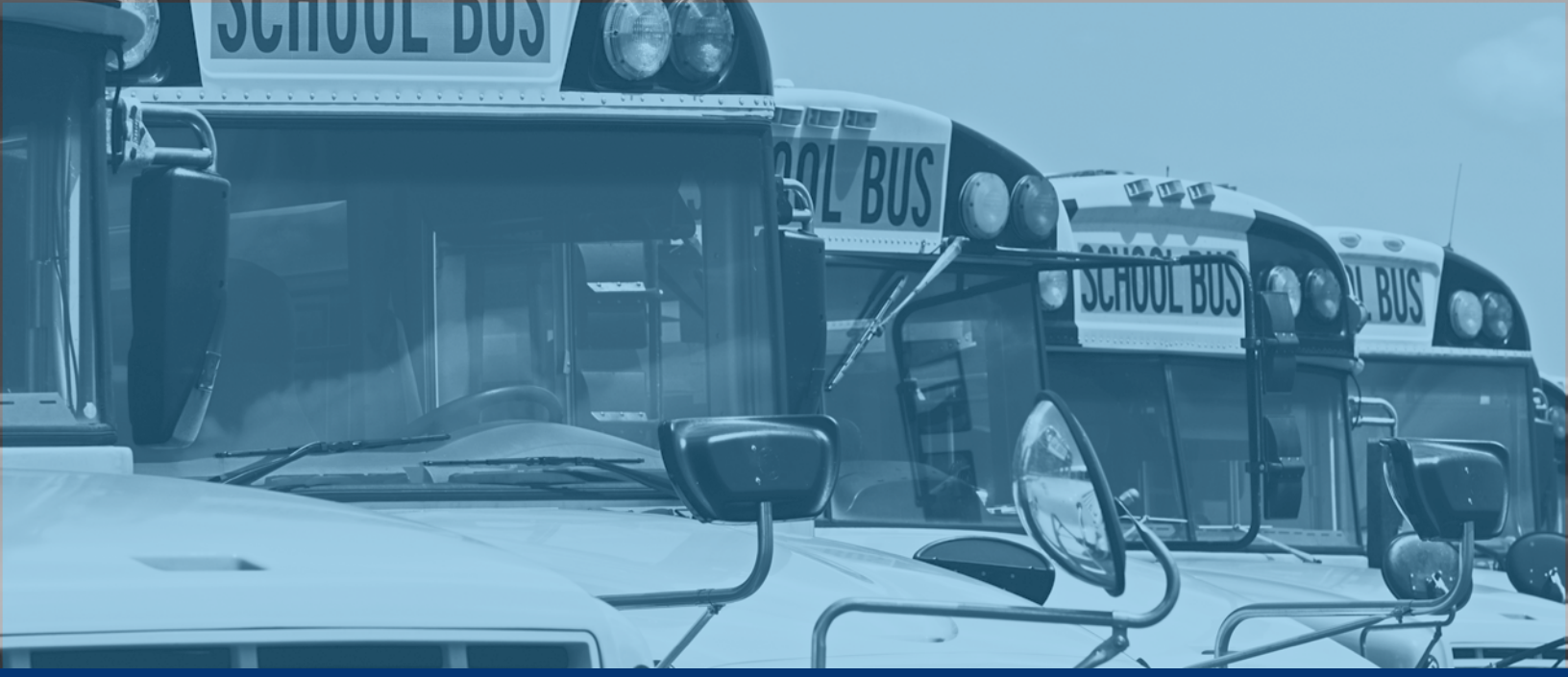
Additional Resources

BTCPower DC Fast Charger Installation and Maintenance Manual – Example maintenance guidance from a charging station OEM manual (see page 21).

Reliability and EV Charging: What Do Fleets Need to Know? – An article written by InCharge Energy regarding charger reliability.

Solus Group's EV Fleet Charging for Electric Delivery Vans: Charging Station Considerations – Provides a list of considerations when setting up fleet charging at a depot.

What you need to know about EV Charger Maintenance: A Comprehensive Guide to Essential Upkeep – An article by BENY on charging station maintenance.



Electric School Bus Guidebook

Guide 9: Safety

NEW YORK STATE | NYSERDA



Understanding the potential risks and mitigation strategies can help ensure safe operations of ESB and chargers.

Electric school buses (ESBs) and chargers include many features that ensure the safety of drivers, maintenance technicians, and other ESB users. This guide explores the safety features of ESBs and chargers, and summarizes best safety practices for drivers, technicians, and first responders.

This chapter of the Electric School Bus Guidebook answers these questions:

- What technology and safety standards exist to ensure ESBs and chargers are safe?
- What are the available fire prevention technologies?
- When should school districts contact first responders?
- Where can I find more information about ESB and charger safety?

Key Activities

Initial actions you can take after reading this chapter include:

- Collect emergency response guides from your ESB and charger dealers and ask about trainings they offer or recommend.
- Purchase any necessary personal protective equipment (PPE) for your maintenance and technician staff.
- Read the user manuals provided by the manufacturers to understand best operating and maintenance practices for your newly purchased equipment.

ESB Safety

In general, electric school buses are very safe; the risk of an ESB catching fire is significantly lower than that of a combustion-powered vehicle.[1] The safety features of ESBs start with their manufacturer design and testing, but in order to keep all users safe, it is important for fleet owners, technicians, drivers, and first-responders to know about the different features of the bus's drivetrain.

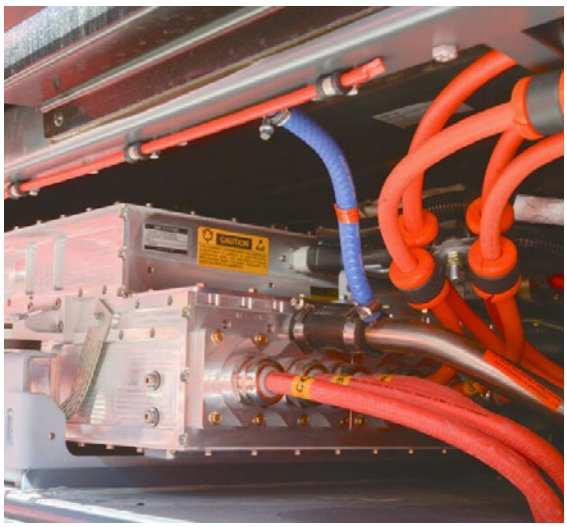


Figure 1: Orange High-Voltage Cabling

ESBs contain high-voltage cabling, which are made clearly visible to technicians by their bright orange color, and equipment including battery packs and electric drivetrains (Figure 1). Servicing this equipment requires special training and personal protective equipment (PPE), such as insulated rubber gloves and proper footwear. This work is typically performed by certified technicians at the local dealership, especially while buses are under manufacturer warranty. While many of the non-warranty maintenance and repair procedures are similar to those of conventional buses, technicians should also receive general training before performing maintenance on ESBs. Training is recommended for any staff that may come in contact with the ESB drivetrains, battery packs, and high voltage wiring, even if they are not directly servicing these components. Additional information on training can be found in Guide 10: Workforce Development.

Charger Safety

Chargers are required to meet strict technical national and international codes and standards.[2,3] It is important to confirm with your dealer that the charger you purchase and install meets all required safety standards and codes to ensure safe and reliable usage. These standards and codes regulate the type of components charger equipment use, ensure the functionality of internal and external electrical conductors and equipment, and verify electrical load and equipment load ratings of chargers and ESBs.

Charger components typically include an enclosure certified by the National Electrical Manufacturers Association (NEMA)[4], electronics, a power connection, flexible electric cables, connectors that plug into the ESB, and in some cases, network connectivity hardware.[5] While most charger components are protected by the enclosure, the ports, charging cables, and connectors are outside the housing. The exposed components are used for charging operations and are safe to use under normal operating conditions, including hot and cold temperatures and wet conditions. Users should always visually inspect these exterior components for any damage before connecting to an ESB.

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[1] https://sfregionalcouncil.org/wp-content/uploads/2023/08/Blue-Bird-Emergency-Response-Guide.pdf
[2] https://share.ansi.org/evsp/ANSI_EVSP_Roadmap_June_2023.pdf
[3] https://www.nrel.gov/docs/fy21osti/78085.pdf
[4] https://www.nema.org/docs/default-source/nema-documents-libraries/electric-vehicle-supply-equipment-systems-trifold.pdf
[5] https://www.besen-group.com/what-are-the-main-components-of-ev-chargers/#:~:text=The%20power%20supply%2C%20charging%20cable,role%20in%20the%20charging%20process

ESB and Charger Fire Safety

Electric vehicles are far less likely to be involved in fires than those powered by diesel or gasoline. The federal National Transportation Safety Board collects data on vehicle fires and an analysis of that data found that, in 2022, 1,530 gasoline-powered vehicles per 100,000 were involved in vehicle fires while only 25 electric vehicles per 100,000 were involved in fires (Figure 2).[6] As of early September 2023, there are over 1,200 ESBs deployed in the United States.[7] Out of these, only one bus fire has been reported, and this was attributable to a computer component failure and the fire did not spread to the battery.[8]

While fires involving ESBs occur far less frequently when compared to diesel/gasoline buses, they can reach higher temperatures and require more water and time for fire service personnel to extinguish. You can install, or upgrade an existing, fire prevention system to limit damage and reduce fire spread in the rare event of a battery fire. National Fire Protection Association (NFPA) has developed useful resources that can be shared with drivers and other maintenance staff to help prepare for ESB emergencies.

Fast Facts: NEMA enclosures

- NEMA enclosures are rigid casings around chargers designed to prevent electric shock and protect electronics from environmental hazards such as water intrusion.
- Your charger installer should note in their contract that they must install NEMA enclosures in compliance with NFPA 70, National Electric Code, which ensures people and surrounding equipment are properly protected against electrical hazards.

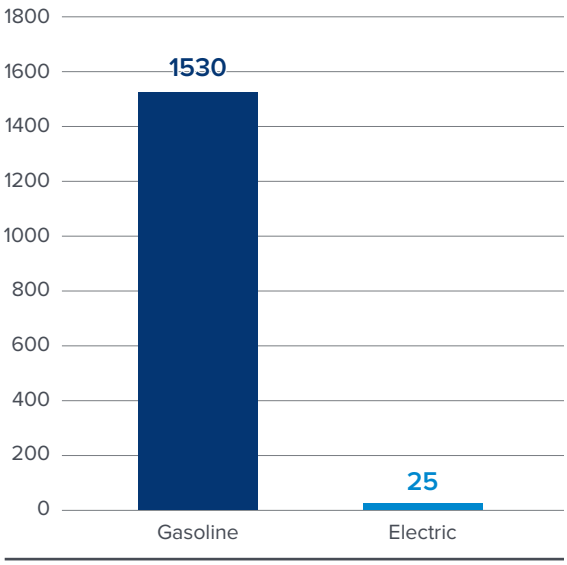


Figure 2: Vehicle Fires

Fire Prevention: ESB Equipment

The best way for fleet owners to minimize fire risk is to continue purchasing high-quality and rigorously-tested products, which electric school bus equipment manufacturers all offer. The following fire and general safety considerations are part of the development and ongoing improvement of ESBs:

- **Extensive battery testing.** ESB batteries must follow globally recognized safety standards that include SAE J2929 and ISO 26262. Additionally, lithium-ion batteries must have UL and UN safety certifications.[9] All standards must be met for a vehicle to be certified for sale.
- **Increasingly stable battery chemistry.** The chemistry in lithium-ion batteries, which are used in almost all ESBs, is more stable than that of batteries commonly used in EVs. This chemistry enables the battery to operate through long durations of high temperatures, which decreases the chances of fire.
- **Substantial battery protection.** ESB batteries are housed in a protective casing, which is typically constructed from steel or aluminum and protects the battery cells from mechanical damage, creates an airtight and waterproof seal, cushions battery cells against vibrations, and helps protect other ESB components from battery fires.[10]
- **Battery management system.** ESB batteries are equipped with Battery Management Systems (BMS), which regulates voltage, temperature, and humidity levels to minimize cell damage and fire risk.[11] In the event of an ESB collision or short circuit, emergency disconnect switches automatically disengage the battery from the high-voltage systems to protect against electrical arcing and reduce fire risk.
- **Collision safety measure.** ESB batteries are centered under the chassis in the middle of the bus, which creates a lower and more stable center of gravity. This design feature helps prevent damage to the battery from collisions, rollovers, and tipping during sharp turns.[12] Emergency electrical disconnects automatically activate when a collision or short circuit is detected.

[6] https://www.kbb.com/car-news/study-electric-vehicles-involved-in-fewest-car-fires/
[7] https://www.wri.org/insights/where-electric-school-buses-us
[8] https://sierrawave.net/small-fire-erupts-in-electric-school-bus-swift-action-by-bishop-volunteer-fire-department-prevents-disaster/
[9] https://www.shopulstandards.com/ProductDetail.aspx?productId=UL1642
[10] https://blog.evbox.com/what-are-ev-batteries-made-of#:~:text=Finally%2C%20the%20individual%20cells%20are,protects%20it%20against%20mechanical%20damage
[11] https://afdc.energy.gov/files/u/publication/electric-school-bus-us-market-study-buyers-guide.pdf?da24b3ed9c
[12] https://electricschoolbusinitiative.org/all-about-electric-school-bus-battery-safety

Fire Prevention: Charger Equipment

Fleet operators must practice prevention via regular maintenance and safe charging. Before connecting a charger to an ESB, the connector and connector port should be inspected to ensure there are no obstructions. Users should also confirm there is no damage to the connector or connector port. If there is an obstruction or damage, contact the dealer or a licensed technician for repairs.[13] Similarly, users should inspect cabling for any damage such as nicked or frayed cords or exposed wiring. When charging is complete, users should unplug the connector from the charging port and place it in the appropriate receptacle located on or near the charger as directed in the charger user manual. Chargers are weather resistant and can be used in the rain and in hot or cold weather without any additional safety considerations.[14] Make sure to follow all manufacturer-provided charger operation and safety documentation to understand the function of your installed charger before using. Refer to Guide 8: Charger Operations and Maintenance, for more information.

Fire Prevention: Collision Response

If a collision occurs, a thorough visual inspection of the battery by authorized personnel (e.g. trained technicians, supervisors, etc.) should be conducted before redeployment to ensure no damage has occurred. Damaged batteries are more likely to result in a fire. If an ESB battery appears to have been damaged, the ESB should be kept at least 50 feet from other structures or vehicles to prevent the spread of fire, should it occur.[15] Additionally, contact your dealer, who will perform any necessary battery maintenance or replacement required for the safe operation of your ESBs.

Fire Response

A critical part of minimizing fire risk and maintaining high levels of safety on and around electric school buses is engaging early and often with local fire and first response teams. ESB alert systems for potential battery fires, based on overheating, off-gassing or other warning signs, generally provide notification before a fire breaks out or spreads. Knowing what to do immediately after an alert is critical. The following steps can help fleet owners and employees be prepared in the event of an incident:

- Meet your fire department early in the process so they are familiar with both the buses and the chargers before responding to any event. Fire personnel should also be familiarized with where the shut off switches are.
- Manual “shut off” switches for the chargers should be clearly labeled and located near an entrance or the fire service information point to assist the fire department in the event of a fire.
- Provide fire extinguishers and fire blankets rated for your ESB battery type to control small fires before they grow.
- Identify and ensure employees are aware of where to bring a bus that is showing signs of a potential battery issue.

Additional Resources

The National Fire Prevention Association (NFPA) – The webpage for NFPA alternative fuel vehicles safety and training resources.

Alternative Fuels Data Center – The U.S. Department of Energy’s webpage on maintenance and safety for electric vehicles.

ESB manufacturers have worked independently and with the NFPA to prepare emergency and first responder guides for their vehicles. ESB emergency and first responder guides from electric school bus manufacturers include:

- Thomas Built Electric Buses 2020 Emergency Response Guide
- IC Bus Electric Buses First Responder Guides
- Lion Electric Buses 2020 Emergency Response Guide
- Blue Bird Electric Buses 2019 Emergency Response Guide

FEMA Electric Vehicle Charging Safety Tips – FEMA webpage for EV fire prevention and charger operating and installation safety tips.

[13] https://evitp.org/newyork
[14] https://www.nhtsa.gov/vehicle-safety/electric-and-hybrid-vehicles
[15] https://www.automotive-fleet.com/10209851/putting-ev-battery-risks-and-safety-into-perspective