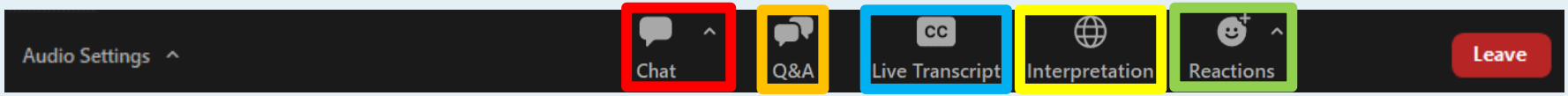
EPA CLEAN SCHOOL BUS

Fleet Planning & Route Analysis w/ Joint Office of Energy and Transportation

July 11, 2023 @ 1 PM ET

Office of Transportation and Air Quality
U.S. Environmental Protection Agency

Zoom Webinar Logistics



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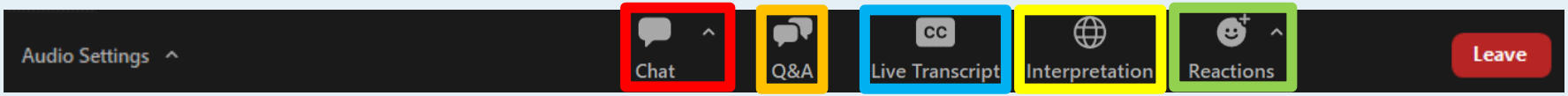

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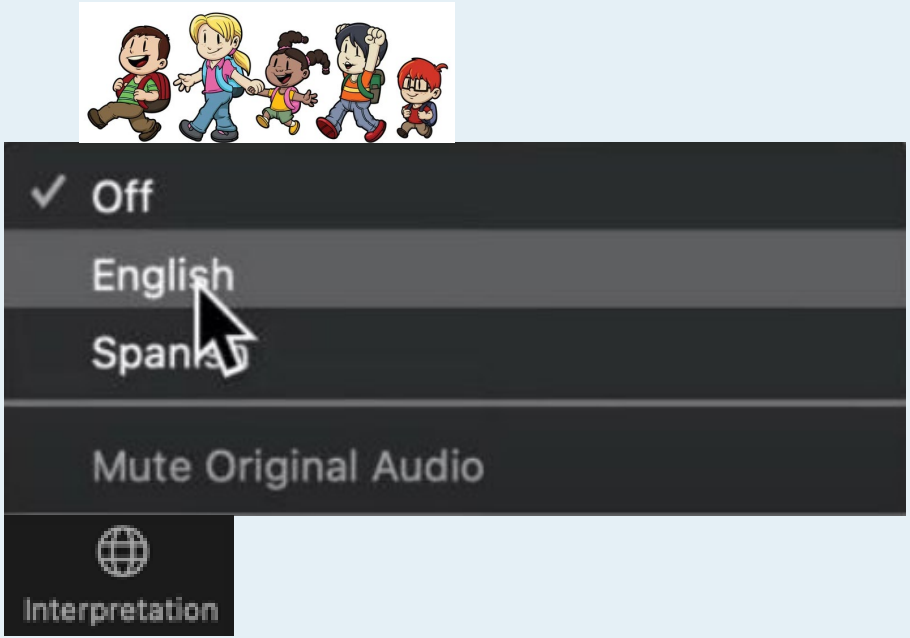
- **Preguntas:** Use la función Q&A [preguntas y respuestas] para hacer preguntas durante la presentación. Abordaremos todas las que sea posible después de la presentación. Si no podemos contestar su pregunta en este momento, anotaremos todas las preguntas y respuestas en el documento Q&A correspondiente disponible en nuestro sitio web. Puede también enviar preguntas por escrito a la línea directa de ayuda del Programa de Autobuses Escolares Limpios de la EPA en cleanschoolbus@epa.gov.
- **Chat** Se encuentra inhabilitado el chat, pero los presentadores podrían compartir enlaces a través de la función de chat.
- **Reacciones:** Las reacciones están habilitadas para que usted interactúe con el presentador.

Live Transcription / Transcripción simultánea

Live Spanish Interpretation / Interpretación simultánea



Agenda

Overview of the Clean School Bus (CSB) Program

2023 CSB Grant Program Overview

Utility Engagement Pledge

Fleet Planning & Route Analysis with Joint Office of Energy and Transportation

Question & Answer Session

Next Steps and Resources

Overview of the Clean School Bus Program

Under **Title XI: Clean School Buses and Ferries**, the Bipartisan Infrastructure Law (BIL) provides **$5 billion** over five years (FY22-26) for the replacement of existing school buses with zero-emission and clean school buses.

These new clean school bus replacements will produce either **zero or low tailpipe emissions** compared to their older diesel predecessors.

School bus upgrades funded under this program will result in **cleaner air on the bus, in bus loading areas, and in the communities in which they operate**.

The first funding opportunity was the **2022 Clean School Bus Rebate Program**. The second funding opportunity is the **2023 Clean School Bus Grant Program Notice of Funding Opportunity** (NOFO), which opened on April 24, 2023, and will **close on August 22, 2023**.

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EPA CLEAN SCHOOL BUS

2023 CSB Grant Program Overview

EPA anticipates awarding approximately **$400 million** in CSB funding under this FY23 Notice of Funding Opportunity (NOFO).

This NOFO **includes two sub-programs**, one for school district and Tribal applicants (**School District Sub-Program: 15-50 buses**) and one for third-party applicants benefitting at least four school districts (**Third-Party Sub-Program: 25-100 buses**).

Eligible activities include the replacement of existing internal-combustion engine (ICE) school buses with **electric, propane, or compressed natural gas (CNG) school buses**, as well as the purchase and installation of **electric vehicle supply equipment (EVSE) infrastructure**.

EPA is prioritizing applications that will replace buses serving **high-need local education agencies, Tribal school districts funded by the Bureau of Indian Affairs or those receiving basic support payments for students living on Tribal land, and rural areas.** EPA is committed to ensuring the CSB Program delivers on the **Justice40 Initiative to ensure that at least 40% of the benefits of certain federal investments flow to disadvantaged communities.**

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Application packages must be submitted to EPA via Grants.gov no later than 8/22/23 at 11:59 p.m. ET.
For more information, please visit *www.epa.gov/cleanschoolbus.*

EPA CLEAN SCHOOL BUS

CSB Funding per Replacement Bus

School District Prioritization Status	Replacement Bus Fuel Type and Size					
	ZE* – Class 7+	ZE* – Class 3-6	CNG– Class 7+	CNG – Class 3-6	Propane – Class 7+	Propane – Class 3-6
Buses serving school districts that meet one or more prioritization criteria	Up to $395,000 (Bus + Charging Infrastructure)	Up to $315,000 (Bus + Charging Infrastructure)	Up to $45,000	Up to $30,000	Up to $35,000	Up to $30,000
Buses serving school districts that are not prioritized	Up to $250,000 (Bus + Charging Infrastructure)	Up to $195,000 (Bus + Charging Infrastructure)	Up to $30,000	Up to $20,000	Up to $25,000	Up to $20,000

**Funding levels include combined bus and EV charging infrastructure. Recipients have flexibility to determine the split between funding for the bus itself and the supporting infrastructure.*

Vehicle and Infrastructure Costs: Eligible project costs include the purchase price of eligible vehicles as shown on this slide and electric vehicle supply equipment (EVSE) infrastructure for new electric buses

Project Implementation Costs: Eligible additional project costs also include those costs directly related to the implementation, management, and oversight of the project. Please refer to the NOFO for additional specific information.

EPA

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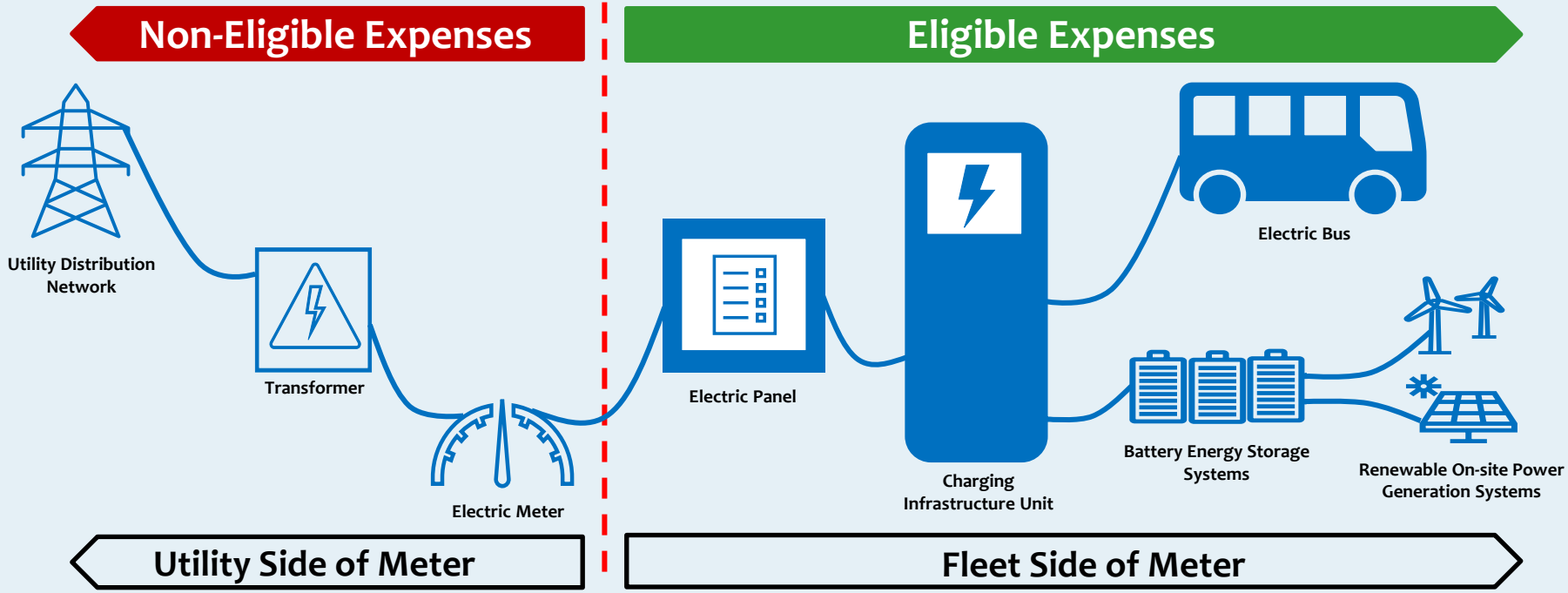
Infrastructure Funding Restrictions



- EPA funding for infrastructure is **limited to the fleet's side of the meter**. May include installation, upgrades (including software and telematic equipment) and permits. Funds may also be used for battery energy storage systems (BESS) associated with new electric school buses, and renewable on-site power generation systems to power the buses and equipment, if on the fleet side of the meter.
- **All Level 2 charging infrastructure purchased under this program must be EPA ENERGY STAR certified chargers.** EPA recommends that all other charging infrastructure (e.g. DC Fast-Charge) purchased under this program be listed by a Nationally Recognized Testing Laboratory (NRTL).

Utility Engagement Pledge

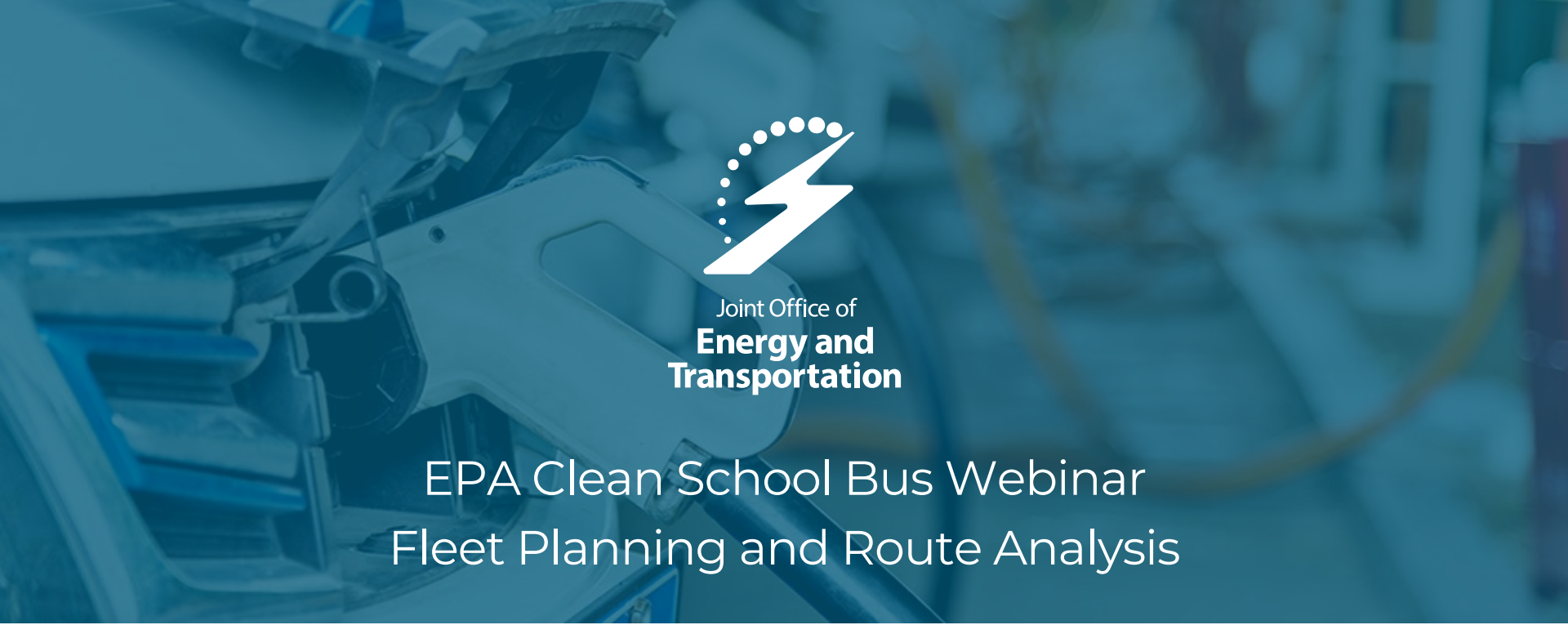
A primary barrier school districts are facing is uncertainty around charging infrastructure deployment and how to engage with electric companies

- **Installation of charging infrastructure can undergo long lead times and requires close coordination with the local utility**

EPA is working with national electric utility company organizations to support school districts through a Utility Pledge that includes:

- **Facilitating Communication Between Electric Providers and School Districts**
- **Providing Technical Support and Assistance**
- **Increasing Funding and Deployment**

Additional information on the Utility Pledge and other technical assistance resources are available on: [epa.gov/cleanschoolbus technical assistance]



Joint Office of
Energy and
Transportation

EPA Clean School Bus Webinar
Fleet Planning and Route Analysis

July 11, 2023

driveelectric.gov

Welcome!

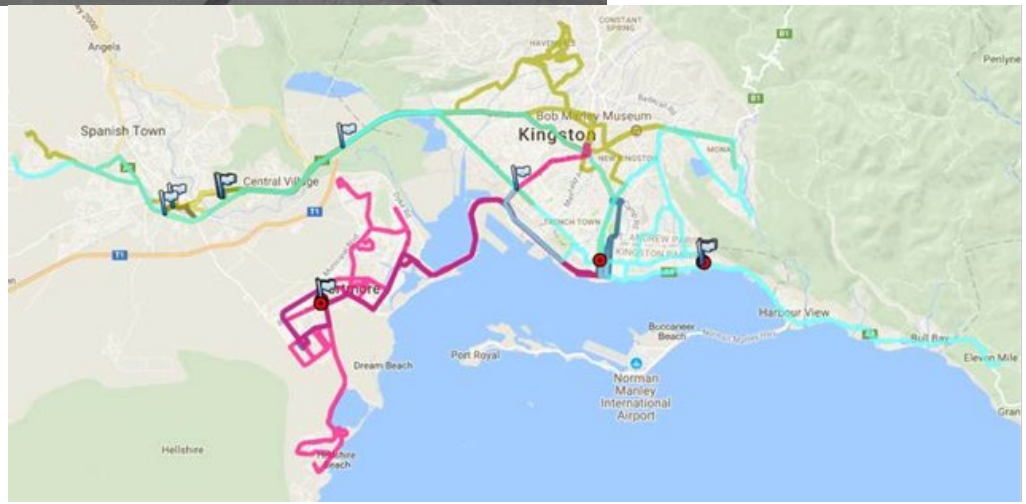
The National Renewable Energy Laboratory (NREL) and the Joint Office of Energy and Transportation (Joint Office) are partnering with the U.S. Environmental Protection Agency (EPA) to offer clean school bus technical assistance to school districts.

CleanSchoolBusTA@nrel.gov

Battery Size kilowatt-hour (kWh)

Range (miles)

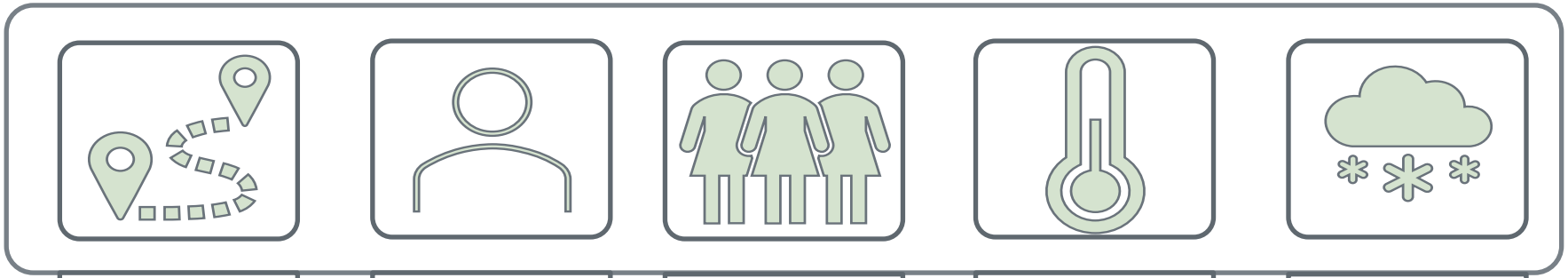
Bus Efficiency (kWh/mile)



Battery Size (kWh)

- Electric School Bus (ESB) battery sizes range from under 100 kWh to over 300 kWh
- Larger batteries = longer range
- Some ESB models offer multiple battery sizes.

Bus Range



Duty Cycle

- Traffic, average speed, number of stops, terrain

Driver Style

- Aggressive drivers will lower range

Bus Loading

- More weight/ riders = less range

Ambient Temp.

- HVAC affects efficiency

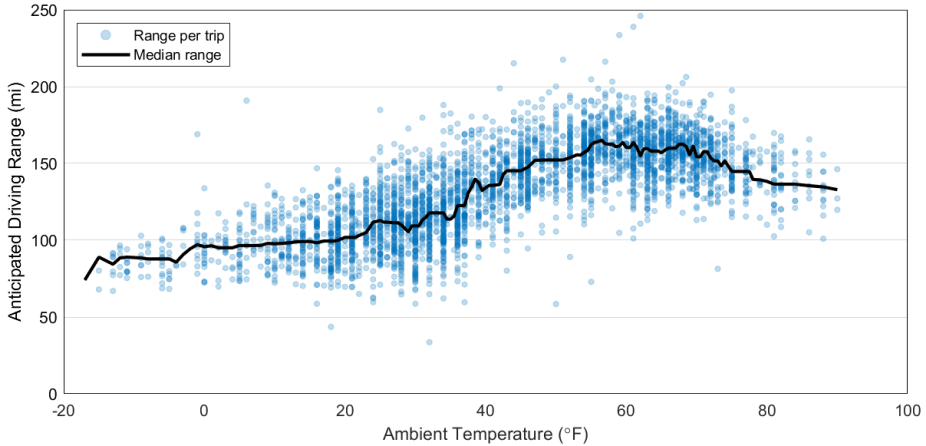
Adverse Weather Conditions

- Snow and rain

Real World Cold Weather Examples: ESB and Battery Electric Bus (BEB) Fleets

Duluth Transit Authority – Duluth, MN

- 2019-2021 study saw a range decrease of approximately 33% for a temperature decrease of 30°F (https://www.nrel.gov/docs/fy22osti/83038.pdf)
- BEBs are approximately 3x as energy efficient as the diesel fleet
- BEBs utilize auxiliary cabin heaters in colder weather.



Tok Transportation – Tok, AK

- Has operated one Type C ESB since 2020 with only electric heat
- Successfully completing routes under -35° F
- Experiences an efficiency decrease of 20%-25% for every temperature decrease of 30°F, which maxes out around 55% efficiency decrease at negative 10-20°F
- Bus is stored and charged inside.

- ESB Range Impacts

- Best Case
  - 60-70°F day
  - Little/no HVAC usage
  - Perform pre-trip while charging
  - Efficient regenerative braking capture (20%-30%)
  - These days you can experience at or within 10%-15% of OEM rated efficiency.

- Worst Case
  - Extreme cold/heat
  - Forget to pre-condition while charging
  - Traffic/long stops
  - Poor regenerative braking/aggressive driving
  - These days MAY cause range to be reduced by 50%-60%.

How to Maximize Range in ESBs

- Train your drivers on good habits
- Pre-condition the bus prior to each route while plugged in
- Consider indoor storage and charging
- Turn off cabin heat when students exit
- Monitor telematics to identify inefficiencies
- Minimize door opening times
- Consider auxiliary heaters in extreme cold

Bus Efficiency (kWh/mile)

- Efficiency = battery size ÷ range
- More efficient bus = lower efficiency number.

OEM Rated Efficiencies

Type	Make/Model	Battery Size	Range	Efficiency
A	Bluebird Microbird G5	88	100	0.88
A	BYD Type A	141	105	1.34
A	Collins Type A	125	130	0.96
A	Greenpower Nano Beast	118	140	0.84
A	LionA (80 kWh)	80	75	1.07
A	LionA (160 kWh)	160	150	1.07
C	Bluebird Vision Electric	155	120	1.29
C	IC Bus Electric CE	315	200	1.58
C	LionC (126 kWh)	126	100	1.26
C	LionC (168 kWh)	168	125	1.34
C	LionC (210 kWh)	210	155	1.35
C	Thomas C2 Jouley	226	138	1.64

Range/Efficiency Impacts

- Battery Size: 150 kWh
- OEM Rated Range: 100 miles

- OEM Rated Efficiency:
  - 150 kWh/100 miles = 1.5 kWh/mile
- 20% Less Range:
  - 150 kWh/80 miles = 1.875 kWh/mile
- 50% Less Range:
  - 150 kWh/50 miles = 3.0 kWh/mile.

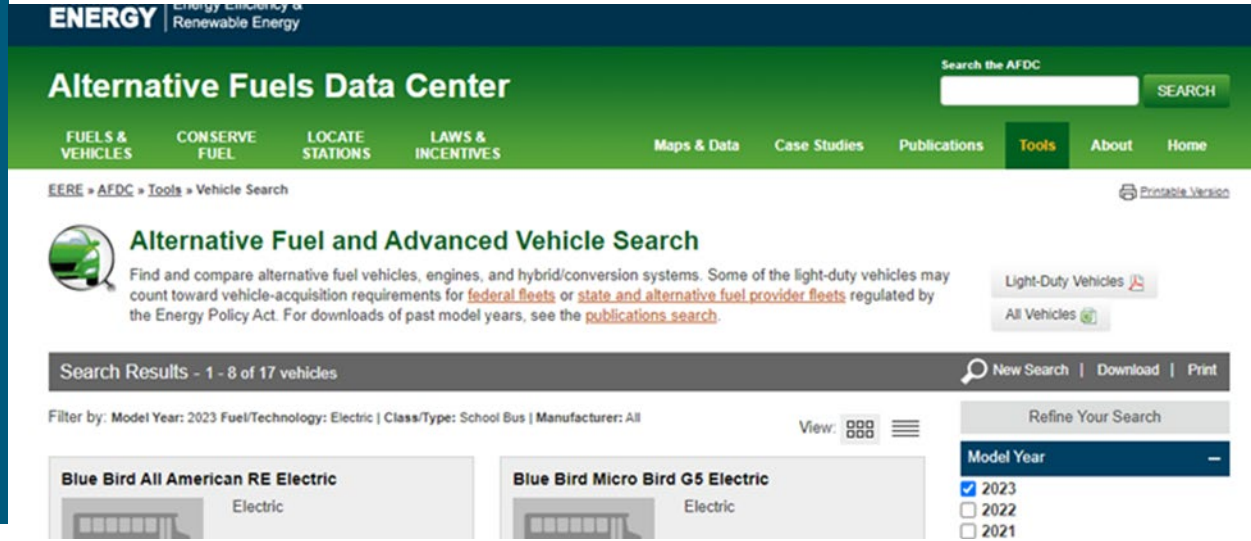
Route Analysis Step 1:

- Understand your bus efficiency (kWh/mile) in worst case scenario

ESB Resources

- AFDC Vehicle Search Tool
- School Transportation News Buyer's Guide
- CALSTART ZETI Tool.

1. Consult with your OEM/dealer
2. Consult with local ESB fleets
3. Reach out to cleanschoolbusTA@nrel.gov.



Bus Efficiency Example

1. OEM has seen buses in region with your specs up to 2.1 kWh/mile

2. Local ESB fleet has seen a max of 30% range/efficiency reduction in their similar buses.
   - 150kWh ÷ 70 miles = 2.14 kWh/mile

3. NREL/JO calculates 2.3 kWh/mile.

Route Analysis Step 2:

- Determine your Route Energy Usage (kWh)

Route Energy Usage (kWh) =
Bus Efficiency (kWh/mile) x Route Distance (miles)

- Bus Efficiency 2.3 kWh/Mile
- 25-mile morning route/25-mile afternoon route

  - Mid-Day Charging
    - 2.3 kWh/mile x 25 miles = 57.5 kWh
  - No Mid-Day Charging
    - 2.3 kWh/mile x 50 miles = 115 kWh

- Why Mid-Day Charging?
  - Can reduce battery size needed
  - Can reduce charger size needed
  - Can enable longer routes
- Why Not?
  - If you are subject to prohibitive time-of-use rates or demand charges.

Route Analysis Step 3:

- Determine if your bus battery size meets your requirements

- Consider battery degradation
  - All batteries will lose capacity over time
  - Most batteries are now warrantied to 80% for 8-12 years

- Consider minimum State-of-Charge (SOC)
  - Give driver's extra confidence on range
  - Build in a buffer

Battery Size (kWh) x (Degradation % - Minimum SOC %) = Usable Battery Capacity

150 kWh x (.8 - .1) = 105 kWh

- Mid-Day Charging = 57.5 kWh route energy

- No Mid-Day Charging = 115 kWh route energy

Route Analysis Step 4: Determine Your Power (kW) Needs

	Level 2 AC	DC Fast Charger (DCFC)
Power Levels	3-19 kilowatt (kW)	15-350+ kW
Facility Power	Single or 3-Phase	Requires 3-Phase Power
Cost	$-$$	$$$-$$$$
Applicability	Lower power, longer durations *should be sufficient for most bus routes	Quick top offs and longer routes that require mid-day charging
Bus Compatibility	AC charging not available on certain ESB models	DCFC is compatible on all current ESB OEM offerings
Network	Both networked and non-networked available	Must be connected to a network
CSB Requirements	Energy Star Certified required	NRTL Listing recommended

Route Analysis Step 4:

- Determine your Power (kW) Needs

Charger Power Needed (kW) =
Route Energy Usage (kWh) ÷ Charging Time (hours)

- Example Charge Times
  - Mid-Day: 9 a.m. return/1 p.m. depart = 4 hours
  - Evening: 4 p.m. return/6 a.m. depart = 14 hours
- Charge battery to 100% during mid-day:
  - 57.5 kWh ÷ 4 hours = 14.4 kW
- Charge battery to 100% during evening:
  - 57.5 kWh ÷ 14 hours = 4.1 kW
- Additional Considerations:
  - Not all ESBs are compatible with Level 2 AC charging
  - BTMS will use charger power to maintain battery temperature on cold days (≈5-10kW), consult OEM.

Determine Optimal Charging Power Level

	Variable	Formula					
A1	Charger Power Level (kW)		6.2	6.3	6.4	6.5	6.6
A2	Battery Size (kWh)		150	150	150	150	150
A3	Range (Miles)		100	100	100	100	100
A4	Route Energy (kWh)		57.5	57.5	57.5	57.5	57.5
A5	Mid-Day Charge Time		4	4	4	4	4
A6	Evening Charge Time		14	14	14	14	14
A7	Battery After Morning Route (kWh)	A2-A4	92.5	92.5	92.5	92.5	92.5
A8	Battery Before Afternoon Route (kWh)	A1*A6+A5	117.3	117.7	118.1	118.5	118.9
A9	Battery After Afternoon Route (kWh)	A7-A4	59.8	60.2	60.6	61	61.4
A10	Battery After Evening Charge (kWh)	A1*A8+A9	146.6	148.4	150.2	152	153.8

- Additional Considerations:
  - Not all ESBs are compatible with Level 2 AC charging
  - BTMS will use charger power to maintain battery temperature on cold days (≈5-10kW), consult OEM.

Sample NREL/JO Route Analysis Tool

Bus Info		Route Info						ESB Factors			Results	
Bus Type	ESB Make/Model	Route #	Route Distance (miles)	Morning Depart Time	Morning Return Time	Afternoon Depart Time	Afternoon Return Time	Low Avg Temp (°F)	Cabin Heater	Mid-Day Charging	Max Energy Used (kWh)	Req'd Charger Power Level (kW)
TypeC	Thomas C2 Jouley	1	40	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	117.0	19.9
TypeC	LionC (168 kWh)	2	25	6:30 AM	8:30 AM	12:00 PM	4:15 PM	20°	Electric	Yes	60.0	6.2
TypeC	Bluebird Vision Electric	3	35	7:30 AM	9:45 AM	1:00 PM	5:15 PM	20°	Electric	Yes	80.7	17.3
TypeC	IC Bus Electric CE	4	20	7:30 AM	9:45 AM	1:00 PM	5:15 PM	20°	Electric	Yes	56.3	5.9
TypeA	BYD Type A	5	40	7:30 AM	9:45 AM	1:00 PM	5:15 PM	20°	Electric	Yes	95.9	29.7
TypeA	Collins Type A	6	15	7:30 AM	9:45 AM	1:00 PM	5:15 PM	20°	Auxiliary	Yes	22.5	3.6
TypeD	Greenpower Beast	7	45	7:30 AM	9:45 AM	1:00 PM	5:15 PM	20°	Auxiliary	Yes	97.2	19.1
TypeA	LionA (160 kWh)	8	12	7:30 AM	9:45 AM	1:00 PM	5:15 PM	20°	Electric	Yes	22.9	3.6
TypeA	Bluebird Microbird G5	9	35	6:30 AM	8:30 AM	12:00 PM	4:15 PM	20°	Auxiliary	Yes	48.1	10.9

*REQUIRES DCFC

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Sample NREL/JO Route Analysis Tool – Bus Comparison

Bus Info		Route Info						ESB Factors			Results	
Bus Type	ESB Make/Model	Route #	Route Distance (miles)	Morning Depart Time	Morning Return Time	Afternoon Depart Time	Afternoon Return Time	Low Avg Temp (°F)	Cabin Heater	Mid-Day Charging	Max Energy Used (kWh)	Req'd Charger Power Level (kW)
TypeC	Bluebird Vision Electric	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	57.7	6.1
TypeC	IC Bus Electric CE	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	70.3	7.0
TypeC	LionC (126 kWh)	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	56.3	7.1
TypeC	LionC (168 kWh)	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	60.0	6.3
TypeC	LionC (210 kWh)	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	60.5	6.3
TypeC	Thomas C2 Jouley	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	73.1	7.2 *REQUIRES DCFC
TypeD	Bluebird All-American RE	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	57.7	6.1
TypeD	BYD Type D	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	66.2	6.7
TypeD	Greenpower Beast	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	61.7	6.4
TypeD	LionD (126 kWh)	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	56.3	7.1
TypeD	LionD (168 kWh)	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	60.0	6.3
TypeD	LionD (210 kWh)	1	25	6:00 AM	9:00 AM	1:00 PM	4:00 PM	20°	Electric	Yes	60.5	6.3

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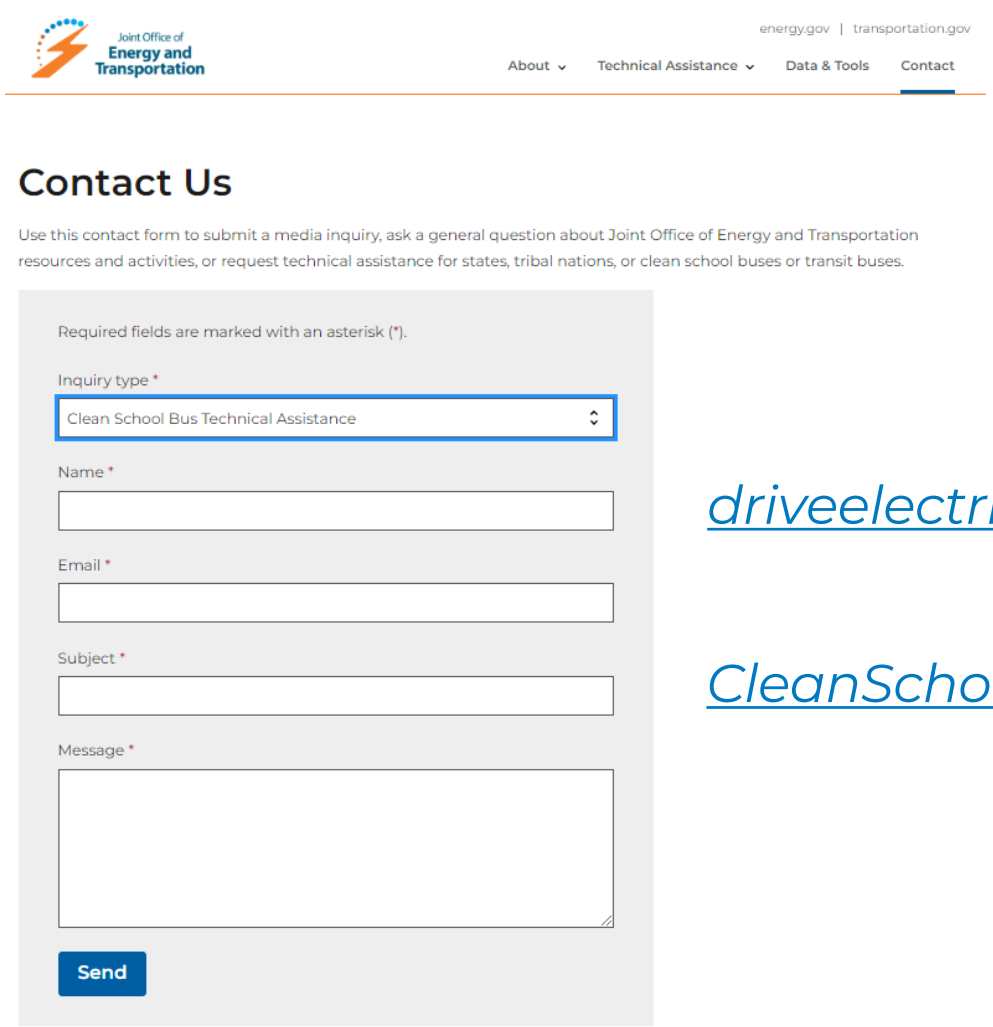
- Request assistance via online form
- Initial response within 48 hours
- General questions and feedback welcome!



driveelectric.gov/bus-contact

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Joint Office of
Energy and Transportation

Thank You

July 11, 2023

CleanSchoolBusTA@nrel.gov

driveelectric.gov

Question & Answer Session

Upvote and comment on questions similar to your own.
Type your full thought so we can follow-up with an answer.
Speak slowly and clearly for the captioner/interpreter.

cleanschoolbus@epa.gov epa.gov/cleanschoolbus

Next Steps – *How to Apply*

1. Visit the Clean School Bus Website for Tools & Resources

2. Register your Organization with Grants.gov and SAM.gov

3. Prepare Application Package

4. Submit Application Package on Grants.gov by August 22nd at 11:59PM ET

EPA

Application packages must be submitted to EPA via Grants.gov no later than 8/22/23 at 11:59 p.m. ET.
For more information, please visit *www.epa.gov/cleanschoolbus.*

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Summary

2023 CSB NOFO

- Application packages must be submitted to EPA via Grants.gov no later than **8/22/23 at 11:59 p.m. ET.**
- Dates and topics for future webinars are on our website under the 'Webinars' section.

Future Funding Opportunities

- EPA encourages school districts to consider which competition structure (grants or rebates) best suits their needs.
- EPA anticipates opening a rebate program in fall 2023.

Resources

- EPA's CSB Program website
- The Joint Office of Energy and Transportation (cleanschoolbusTA@nrel.gov)
- The CSB helpline (cleanschoolbus@epa.gov)

Stay in Touch

- View the full 2023 CSB Grant NOFO at epa.gov/cleanschoolbus/clean-school-bus-program-grants
- Submit questions to cleanschoolbus@epa.gov
- Don't miss any updates! To sign up for the listserv, please visit epa.gov/cleanschoolbus.

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