

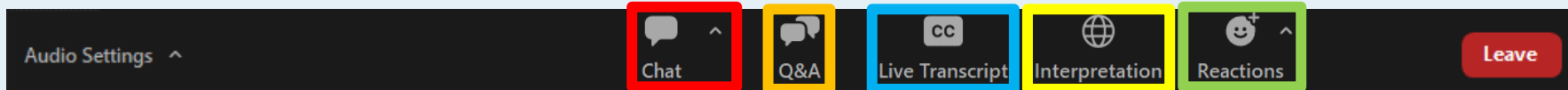


EPA CLEAN SCHOOL BUS

Battery Overview, Recycling/End-of-Life Options, and Warranties
July 31, 2024 @ 1 PM ET

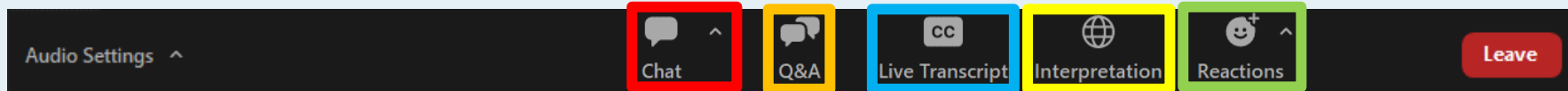
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

Zoom Webinar Logistics



- **This presentation is being recorded.** The slides and recording will be posted to epa.gov/cleanschoolbus as soon as they are processed for posting.
- **All attendees are in listen-only mode.** Audio is available through your computer speakers or by phone. The presenter will ask you to come off mute if applicable.
- **Live transcription:** Live captioning is available by clicking the “Live Transcript” icon.
- **Live interpretation:** Live Spanish interpretation is available by clicking the “Interpretation” icon and selecting Spanish. Click “Mute Original Audio” to mute English audio when listening in Spanish.
- **Questions:** Use the Q&A feature to ask questions during the presentation. We will address as many as possible after the presentation. If we are unable to answer your question at this time, we will list all questions and answers in the Q&A document available on our website. You can also submit written questions to the EPA Clean School Bus Program helpline at cleanschoolbus@epa.gov.
- **Chat:** Chat is disabled, but the presenters might share links through the chat feature.
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Logística de seminarios web en Zoom



- **Esta presentación es grabada.** Las diapositivas y la grabación se publicarán en epa.gov/cleanschoolbus tan pronto sean procesadas para su publicación.
- **Todos los asistentes se encuentran solo en modo escucha.** Hay audio disponible a través de los altoparlantes de su computadora o por teléfono. El presentador le pedirá que quite el silencio si corresponde.
- **Transcripción en vivo:** Hay subtítulos disponibles haciendo clic en el icono “Live Transcript” [Transcripción en vivo].
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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.
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Live Transcription / Transcripción simultánea

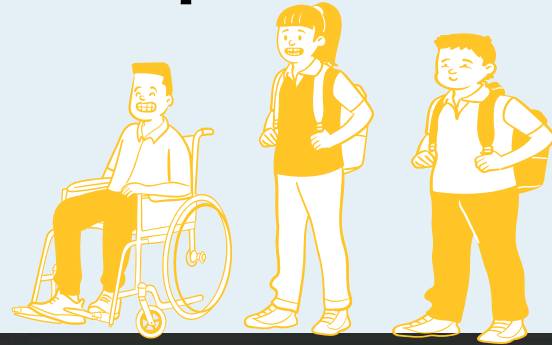


Live transcript is available

CC

Live Transcript

Live Spanish Interpretation / Interpretación simultánea



✓ Off

English

Spanish

Mute Original Audio



Interpretation

AGENDA

Overview of the Clean School Bus
(CSB) Program

CSB Technical Assistance Resources

Battery Overview, Recycling, End-of-
life Options, Warranties w/ JOET

Q&A

Next Steps and Resources

Overview of the Clean School Bus Program

Bipartisan Infrastructure Law

- 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.

Future Funding Opportunities

- The EPA has offered rebates and grants in past funding opportunities.
- The EPA *anticipates* opening another round of CSB rebate funding in Fall 2024.



**EPA CLEAN
SCHOOL BUS**



Why Clean School Buses?



Reduced Greenhouse Gas Emissions

CSBs emit zero or low tailpipe emissions.



Cleaner Air

CSBs result in cleaner air on the bus, in bus loading areas, and in the communities in which they operate.




Cost Savings

Replacing older diesel school buses with CSBs often reduces maintenance and fuel costs.



Resiliency

Bidirectional charging capable CSBs can provide power to the grid or buildings during power shutdowns.



Improved Student Attendance & Achievement

The transport of students with CSBs has been linked to student attendance and academic achievement improvements.

CSB Program Technical Assistance Resources



Technical Assistance

- [Clean School Bus Technical Assistance](#)
- [Charging and Fueling Infrastructure Resources](#)
- [Clean School Bus Case Studies](#)
- **NEW** [Tax Credits](#)



Workforce Development

- [Bus Manufacturer Job Quality and Workforce Development Practices](#)
- [Workforce Development and Training Resources](#)



Educational Materials

- [Clean School Bus Reports to Congress](#)
- [Benefits of Clean School Buses](#)
- [Resources to Engage Your Community](#)

Technical Assistance Webinar Playlist



Clean School Bus: JOET - TA Overview & U...

- Introductions
- Technical assistance overview
- Utility interconnection
 - Utility infrastructure
 - Utility rates and solutions
- Working with your utility
 - How to talk with your utility
 - Electric School Bus (ESB) Charging Station Planning Form

Watch on  YouTube

2023-10-12 13:13:38

Technical Assistance via the Joint Office of Energy and Transportation



Joint Office of
**Energy and
Transportation**

Battery Overview

Clean School Bus Program Webinar

July 31, 2024

driveelectric.gov

Electric School Bus Technical Assistance

NREL and the Joint Office of Energy and Transportation (Joint Office) are partnering with the U.S. Environmental Protection Agency to offer **FREE** clean school bus technical assistance to school districts receiving funds or planning to apply.

Provides school districts with the knowledge, tools, and information needed to successfully plan for and deploy clean school buses.

Clean School Bus Technical Assistance

CleanSchoolBusTA@nrel.gov

driveelectric.gov/contact



A screenshot of the website's news section. At the top, the logo for the Joint Office of Energy and Transportation is on the left, and navigation links for 'About', 'Technical Assistance', 'Data & Tools', 'News & Events', 'Work with Us', and 'Contact' are on the right. Below the navigation, there are tabs for 'News' and 'Webinars'. The main content area features a news item titled 'EPA Announces Clean School Bus Funding' with a photograph of a yellow school bus. The bus has 'SCHOOL BUS' written on the front and a red stop sign on the side. Below the photo, the date 'May 20, 2022' is displayed, followed by a short paragraph of text starting with 'The first round of funding for the Environmental Protection Agency's (EPA) Clean School Bus Program is now available. Beginning today, the Joint Office will offer technical assistance to school districts on electric bus basics, charging equipment, utility connections, bus performance, and operational considerations like routing and'.

Examples of How We Can Help

Coordinating
with electric
utilities

Identifying
available
funding and
incentives

Analyzing
charging
infrastructure
needs

Conducting
route analysis
and planning

Conducting
training and
workforce
development

Opportunities
for resiliency
(V2X)

Analyzing
energy needs
and grid
impact

Identifying
solar and
battery storage
opportunities

Electric School Bus Forum

- Online forum available to electric school bus (ESB) operators.
- Communicate with peers on all things pertaining to electric school buses.

The screenshot shows the top navigation bar of the Electric School Bus Forum. It features the logo for the Joint Office of Energy and Transportation on the left. The main title "Electric School Bus Forum" is centered, with navigation icons for chat, search, menu, and a user profile (R) on the right. Below the title, there are filters for "categories", "tags", "Latest" (highlighted in red), and "Top". A "+ New Topic" button is on the right. The forum lists a single topic: "Welcome to Electric School Bus Forum!" with a "General" subcategory, 0 replies, 6 views, and a date of Mar 4. A gear icon for settings is also visible.

<https://electric-school-bus-forum.nrel.gov/>

ESB Familiarization Training Series

Part 2 – Technology Overview for Technicians Aug. 7, 1 p.m. EST

Register at:

<https://driveelectric.gov/webinars/esb-webinar-series-episode-2>

Brought to you by:

- Joint Office
- NREL
- International Transportation Learning Center (ITLC)
- School bus manufacturers

- Four-part module-based series for operators, technicians, and other school bus fleet members.
- Learn fundamentals of electric school bus technology.
- Live Q&A during each session.
- Recordings with testing materials for internal training programs.



Alternative Fuels Data Center

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STATIONS

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Publications

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About

Home

— School Bus — Electrification Center

A step-by-step guide to the school
bus electrification process.



<https://afdc.energy.gov/guides/electric-school-bus>

High-Voltage (HV) Battery

Stores the energy to run the motor

Measured in kilowatt hours (kWh)

ESBs use Lithium-Ion Batteries

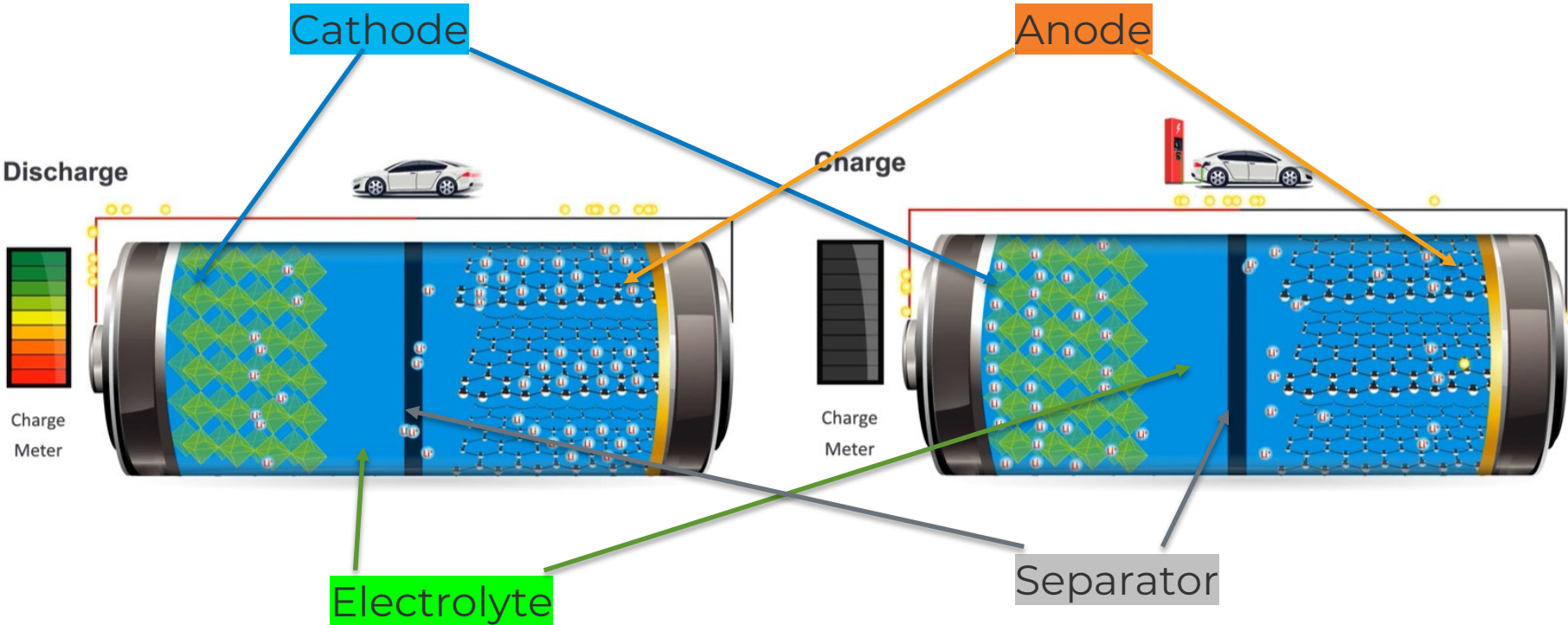
- Nickel Manganese Cobalt (NMC)
- Lithium Iron Phosphate (LFP)

Cells ► Modules ► Pack

- Cells are put in series and parallel to form a module
- Modules make up a pack



How Do Batteries Work



[DOE: How Lithium-ion Batteries Work.](#)

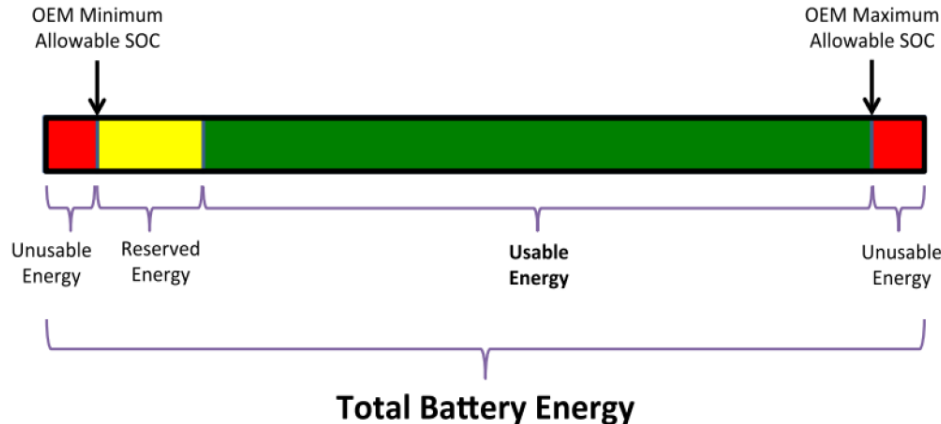
Battery Considerations

ESBs are available with 80-315 kWh batteries

Larger batteries typically equal longer range

- But this formula is not linear
- Larger buses may have lower efficiency

What size battery will enable route completion? What are your requirements around State-of-Charge?



NREL/Joint Office ESB Route Analysis Tool

The Electric School Bus Route Analysis Tool is a spreadsheet tool designed to assist school bus fleets in determining the bus energy usage and charger power needs for their unique routes.

Lowest Expected Temperature (°F):

30°+

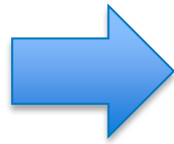
*See NCEI Climate at a Glance for local temperatures:

<https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/county/time-series>

Bus Info		Route Info							User Selections		Energy/Power Results		Charger Selection	
Bus Type	ESB Make/Model	Route #	Morning Route Distance (miles)	Morning Depart Time	Morning Return Time	Afternoon Route Distance (miles)	Afternoon Depart Time	Afternoon Return Time	Cabin Heater	Mid-Day Charging	Max Energy Used (kWh)	Estimated Minimum Charger Power Level (kW)	Charger Size (kW)	Expected Minimum SOC (%)
TypeC	IC Bus Electric CE (315 kWh)	1	50	6:30 AM	8:30 AM	60	12:30 PM	4:30 PM	Electric	Yes	157.5	20.3	20.0	11%
TypeC	LionC (210 kWh)	2	30	6:30 AM	8:30 AM	40	12:30 PM	4:30 PM	Electric	Yes	90.3	13.3	19.2	48%
TypeC	Bluebird Vision Electric	3	35	6:30 AM	8:30 AM	40	12:30 PM	4:30 PM	Electric	Yes	86.1	15.2	19.2	20%
TypeC	BYD Type C	4	20	6:30 AM	8:30 AM	40	12:30 PM	4:30 PM	Electric	Yes	109.9	13.8	19.2	58%

<https://driveelectric.gov/school-districts>

Battery Management System (BMS)



Battery Thermal Management System (BTMS)

Monitoring the battery

Providing battery protection

Estimating the battery's operational state

Continually optimizing battery performance

Maintains operating temperature of the battery

Circulates coolant through the battery components

Batteries operate best at 60-70° F

The BTMS operates even when the bus is off

Fires and Thermal Runaway

EV Battery fires are rare

Thermal runaway can be caused by system failure or damage

Emergency Response Guides: [NFPA](#), [ESA](#), or OEMs and Dealers

Alternative Fuels Data Center, [EV Safety Training Resources for First and Second Responders](#)

National Fire Protection Association [EV Safety Online Training](#)



Degradation

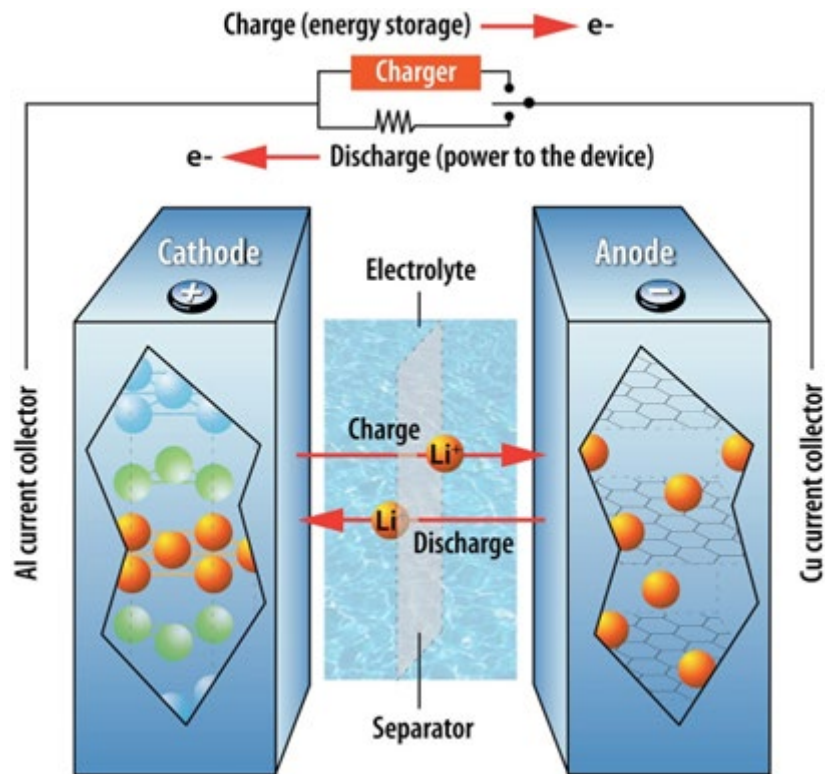
All batteries will lose capacity over time

What affects it

- Fast charging
- Bottom and top outs
- Hot/Cold weather

Best practices

- Keep them at optimal temperature
- Limit fast charging to when needed
- Maintain SOC between 20-80%



[ESBI: Maximize Battery Performance Article](#)

Warranties and Useful Life



ESB batteries warrantied for 8+ years



Extended warranties are available



Understand V2X Impacts on Warranties



Expect batteries to last for the life of the bus



Consider transitioning older buses to shorter routes

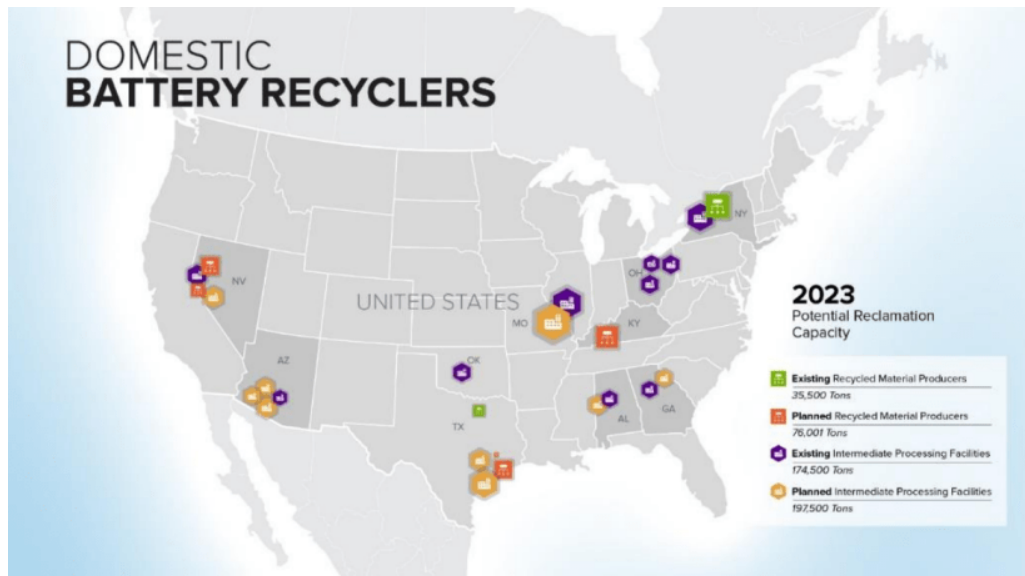
Battery Recycling

Pros

- Reclaim critical materials
- Avoid disposal
- Recycling network is expanding

Cons

- Uses energy, water, and produces GHGs
- Transporting haz waste can be costly and complicated



<https://www.nrel.gov/transportation/li-ion-battery-supply-chain-database-online.html>

Battery Second Life

Utilize batteries as stationary storage once buses are retired

Benefits



- Reduce peak demand
- Reduce the need for grid upgrades
- Reduce emissions from peaker plants
- Power buildings and provide resilience



Battery End-of-Life

Have a Plan

- This starts during procurement
 - [ESBI: RFP Template](#)
- Involve your OEM/Dealer

Second Life Use is Preferred

- Benefits to district, grid, fleet, etc.
- Resilience and/or emergency response

Recycling

- At some point all batteries will need to be recycled
- Reclaim critical materials
- [EPA: Lithium-Ion Battery Recycling](#)

Disposal

- Not an option
- Potential for fires and release of toxic materials to the environment

Future of Batteries

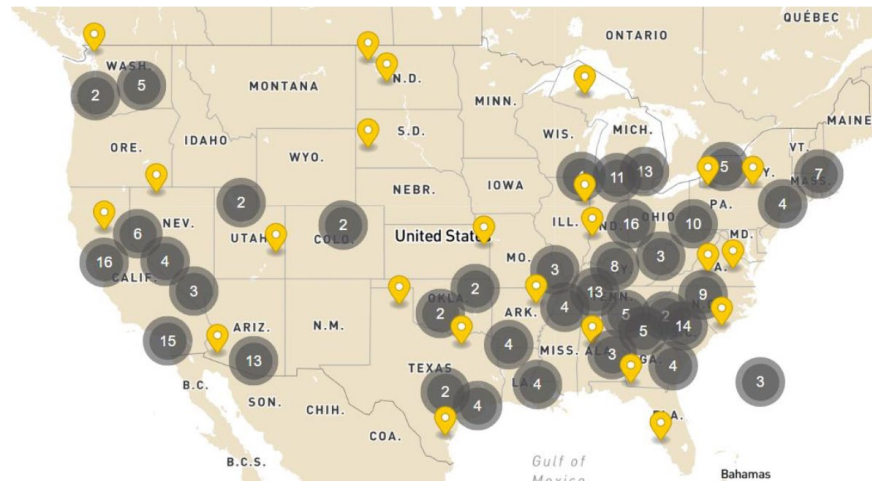
Battery Passport

- Develop digital IDs for batteries
- Use data to improve overall battery quality and track progress towards sustainability

Extended Range

Lower Cost

Solid State



Expanding Production in the US

- [Securing Materials for the US Electric Vehicle Industry](#)
- [NAATBatt](#)
- [Li-Bridge](#)

General Best Practices/Advice

Don't be afraid to start a pilot

Take advantage of unprecedented funding

Size your bus batteries to fit your routes
[ESB Route Analysis Tool](#)

Join the [ESB Forum](#) and connect with peers

Reach out to cleanschoolbusTA@nrel.gov





Joint Office of
**Energy and
Transportation**

Thank you

July 31, 2024

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

Upcoming JOET TA Webinars

August 28, 2024	Building a Case For ESBs in your Fleet including Benefits, Total Cost Of Ownership (TCO), and Emissions Calculators
September 25, 2024	Electrification Process including a Step-by-Step Guide for New Adopters
TBD	TBD



To view the most up-to-date list of CSB webinars and register, please visit:
www.epa.gov/cleanschoolbus/events-related-clean-school-bus-program



**EPA CLEAN
SCHOOL BUS**

Clean Bus Planning Awards (CBPA) Program

- In addition to the free technical assistance provided by NREL for CSB applicants and selectees, **the \$5M Clean Bus Planning Awards Program provides FREE technical assistance** to create comprehensive and customized bus electrification plans for fleets across the United States.
- **Applications for assistance are open on a rolling basis through Sept. 30, 2024**, giving fleets an opportunity to fully understand their needs before applying for support. **This new program will reduce the burden of electrification by helping fleet managers create a step-by-step plan to transition their bus fleet.**
- Learn more at <https://driveelectric.gov/clean-bus-planning-awards> and <https://www.nrel.gov/news/program/2024/clean-bus-planning-awards-support-fleet-electrification-with-custom-transition-plans.html>

Current Funding Opportunities

- The EPA has begun announcing 2023 Rebate selections.
- The CHDV grant program application period closed on July 25, 2024, at 11:59 PM ET.

Future Funding Opportunities

- The EPA encourages school districts to consider which competition structure (grants or rebates) best suits their needs.
- The EPA *anticipates* opening another round of CSB rebate funding in Fall 2024.

Resources

- The Joint Office of Energy and Transportation (cleanschoolbusTA@nrel.gov)
- The CSB helpline (cleanschoolbus@epa.gov)

Stay in Touch

- Learn more about the EPA Clean School Bus Program at epa.gov/cleanschoolbus
 - Learn more about the JOET Clean Bus Planning Awards Program at driveelectric.gov/clean-bus-planning-awards
 - Sign up for the CSB listserv at <https://lp.constantcontactpages.com/su/dgrhRed/cleanschoolbus>
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