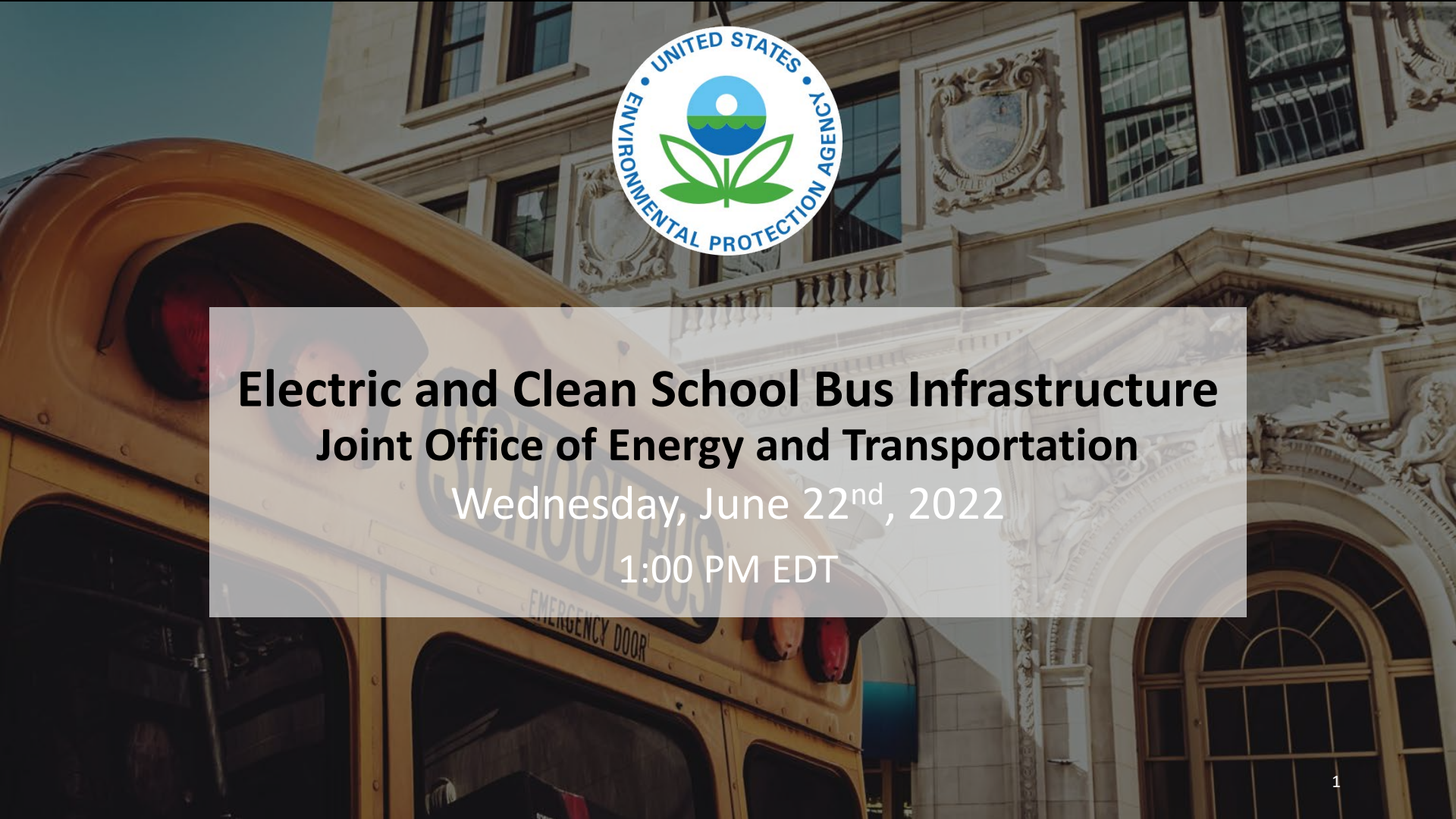


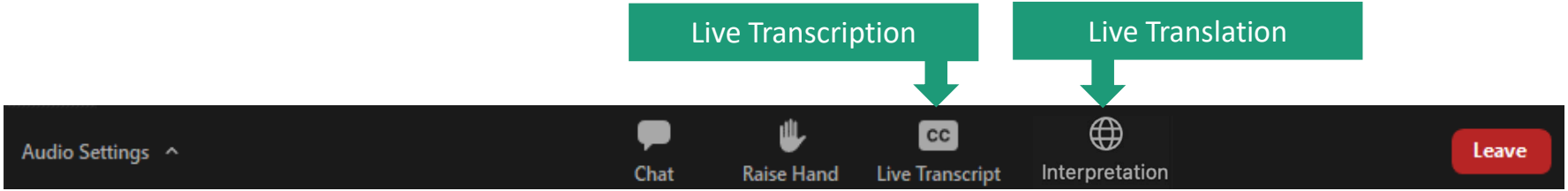
Electric and Clean School Bus Infrastructure

Joint Office of Energy and Transportation

Wednesday, June 22nd, 2022

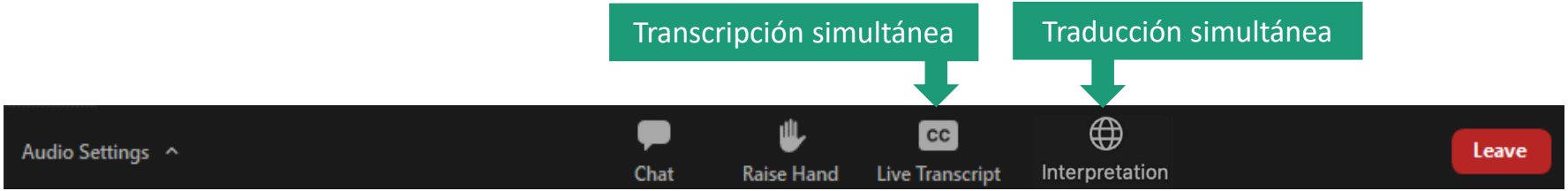
1:00 PM EDT

Zoom Webinar Logistics



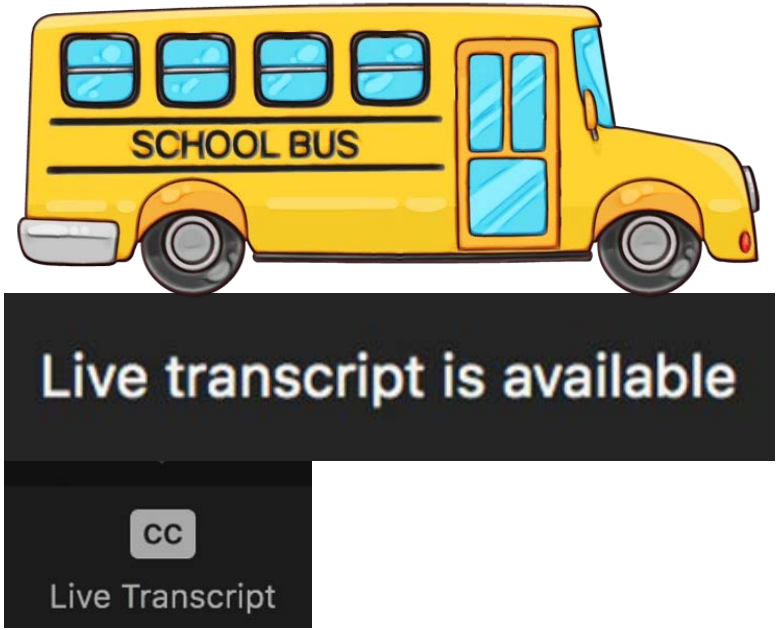
- **This session is being recorded.** EPA will make a copy of the recording and presentation slides available on their website in the near future (https://www.epa.gov/cleanschoolbus).
- **All attendees are in listen-only mode.** Audio is available through your computer speakers or by phone.
- **Technical difficulties:** If you are having technical difficulties, please email cleanschoolbus@epa.gov.
- **Live transcription:** Automated live transcription is available by clicking the “Live Transcript” icon in your Zoom toolbar.
- **Live translation:** Live Spanish translation is available by clicking the “Interpretation” icon and selecting Spanish.
  - Note, to mute English audio when listening in Spanish, click “Mute Original Audio.”
- **Questions:** Submit written questions to the EPA Clean School Bus Program helpline at cleanschoolbus@epa.gov.

Logística del Webinario de Zoom



- **Esta presentación está siendo grabada.** La EPA publicará una copia de la grabación y las diapositivas de la presentación en su sitio web en un futuro próximo (https://www.epa.gov/cleanschoolbus).
- **Todos los participantes están en modo solo de audio.** El audio está disponible a través de los altavoces de su computadora o por teléfono.
- **Dificultades técnicas:** Si tiene dificultades técnicas, envíe un correo electrónico a cleanschoolbus@epa.gov.
- **Transcripción simultánea:** La transcripción simultánea automatizada está disponible al hacer clic en el icono “Live Transcript" en la barra de herramientas de Zoom.
- **Traducción simultánea:** La traducción simultánea al español está disponible al hacer clic en el icono "Interpretation" y seleccionar español.
  - Tenga en cuenta que para silenciar el audio en inglés cuando escuche en español, haga clic en "Mute Original Audio".
- **Preguntas**: Envíe sus preguntas por escrito a la línea de ayuda del Programa de Autobuses Escolares Limpios de la EPA a cleanschoolbus@epa.gov.

Live Transcription / Transcripción simultánea



Live Translation / Traducción simultánea

Overview of the Bipartisan Infrastructure Law 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 clean school buses and zero-emission 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 under this program is the 2022 Clean School Bus Rebates.

Funding Pools and Number of Applications

School districts applying directly for funds may only submit one application to replace up to 25 buses.

EPA will not fund multiple applications for bus replacements that will serve the same school district.

$500 Million in Available Funding for 2022 Clean School Bus Rebates	
Zero Emission Funding Pool:	Clean School Bus Funding Pool:
Applications **exclusively requesting zero-emission** buses	Applications requesting **zero-emission, propane, and/or compressed natural gas (CNG)** buses

The application deadline is August 19, 2022.

School Bus Replacement Funding

The maximum rebate amount per bus is dependent on:

- Bus Fuel Type
- Bus Size
- Whether the school district served by the buses meets one or more prioritization criteria

The table displays maximum funding levels. EPA will not disburse rebate funds in excess of the actual cost of the replacement bus and any costs above the maximum funding level are the sole responsibility of the applicant/awardee.

Maximum Bus Funding Amount per Replacement School 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	$375,000	$285,000	$45,000	$30,000	$30,000	$25,000
Buses serving other eligible school districts	$250,000	$190,000	$30,000	$20,000	$20,000	$15,000

https://www.epa.gov/cleanschoolbus/school-bus-rebates-clean-school-bus-program

Infrastructure Funding

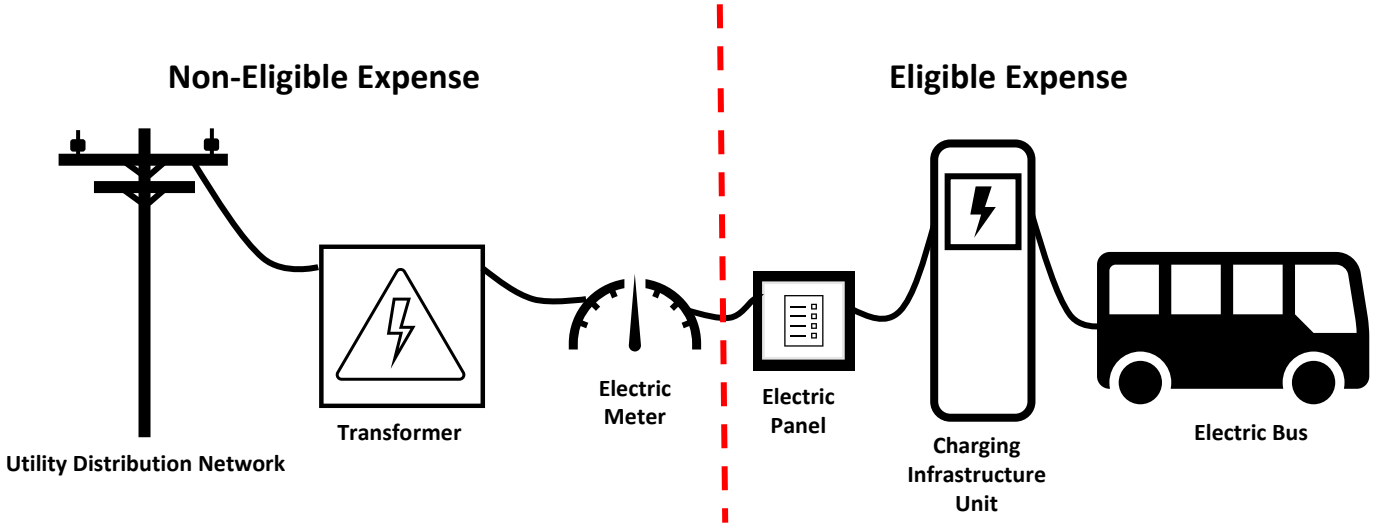
Talk to your utility now if you are interested in zero-emission, electric buses!

This table displays the maximum funding levels per ZE, electric bus. EPA will not disburse rebate funds in excess of the actual infrastructure costs.

School District Prioritization Status	ZE, Electric – Class 3+ Infrastructure Funding
Buses serving school districts that meet one or more prioritization criteria	$20,000/bus
Buses serving other eligible school districts	$13,000/bus

Infrastructure Funding Restrictions

- EPA funding for infrastructure is limited to the fleet's side of the meter (as shown on the right side of the diagram).
- All Level 2 charging infrastructure purchased under this program must be EPA ENERGY STAR certified chargers.
  - EPA strongly recommends that all other charging infrastructure (for example DC Fast-Charge) purchased under this program be listed by a Nationally Recognized Testing Laboratory (NRTL).



2022 Clean School Bus Rebates

Sign up for the Clean School Bus Listserv and continue to check www.epa.gov/cleanschoolbus for updated resources and information on additional webinars.

After reviewing the Program Guide, if you still have questions, please contact cleanschoolbus@epa.gov. Questions will be incorporated in an update to the Q&A document.

The application deadline is August 19, 2022.

Alternative Fueling Infrastructure

EPA's Clean School Bus Program Webinar

June 22, 2022

Jesse Bennett, Abby Brown, John Gonzales, Lauren Lynch

Agenda

1. Introduction
2. Electric Vehicle Infrastructure Overview
3. Propane & Natural Gas Infrastructure Overview
4. Q&A

NREL Science Drives Innovation

Renewable Power

Solar

Wind

Water

Geothermal

Sustainable Transportation

Bioenergy

Vehicle Technologies

Hydrogen

Energy Efficiency

Buildings

Advanced Manufacturing

Government Energy Management

Energy Systems Integration

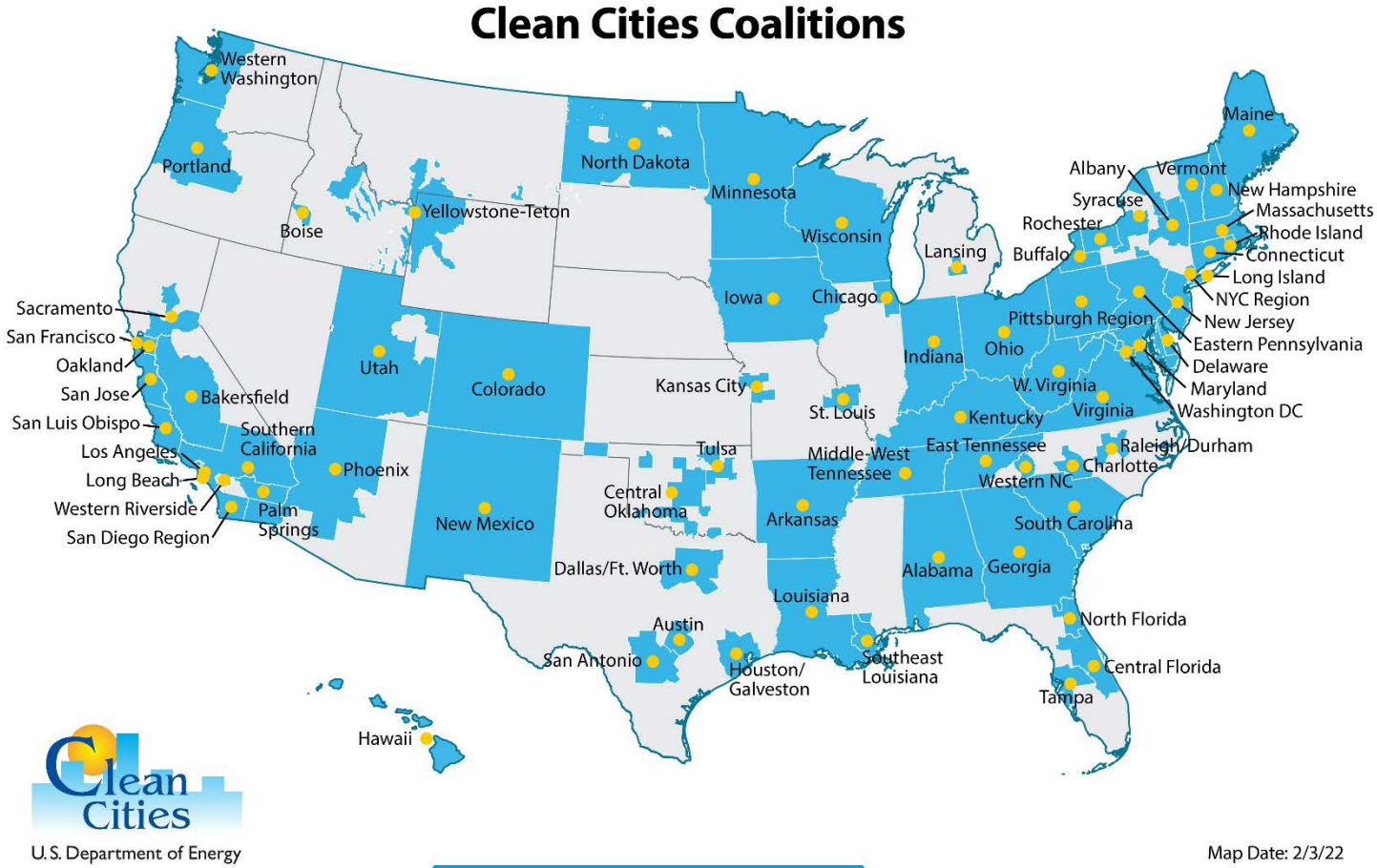
Grid Integration

Hybrid Systems

Security and Resilience

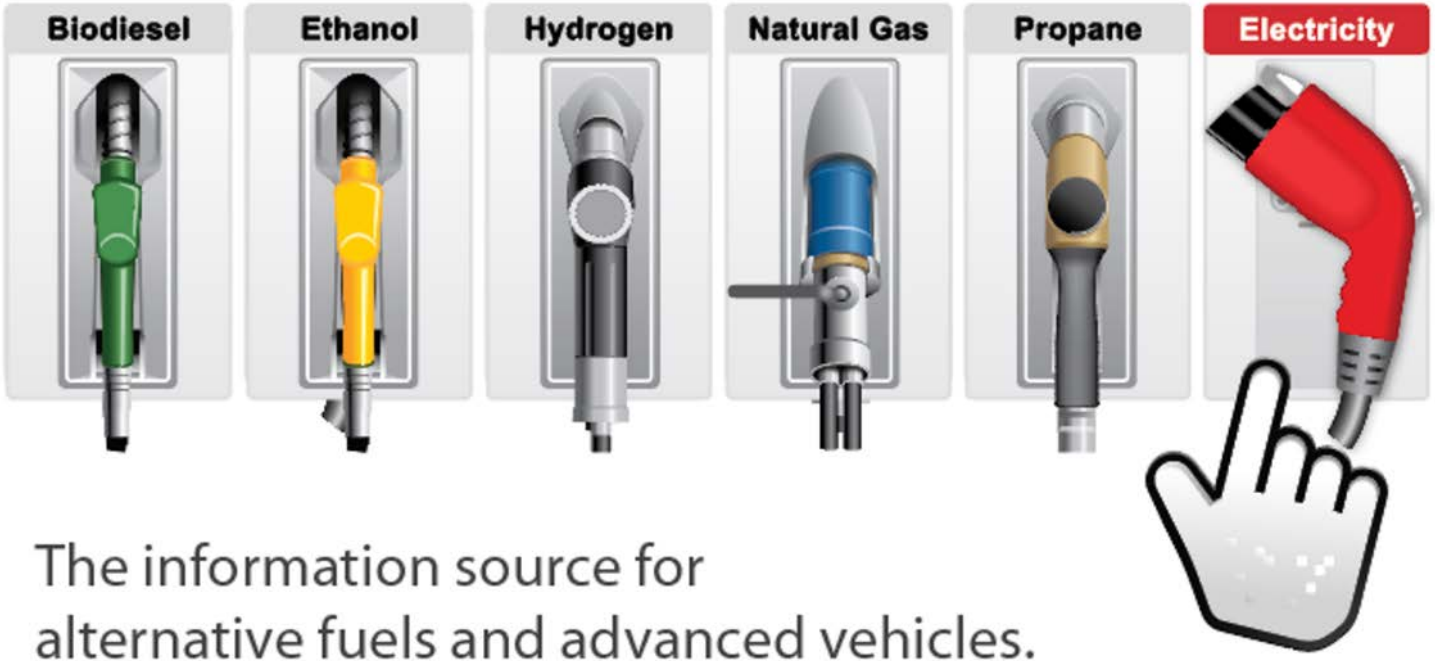
National Network of Clean Cities Coalitions

More than 75 active coalitions covering nearly every state with more than 20,000 stakeholders



cleancities.energy.gov

Alternative Fuels Data Center (AFDC)



The information source for
alternative fuels and advanced vehicles.

afdc.energy.gov

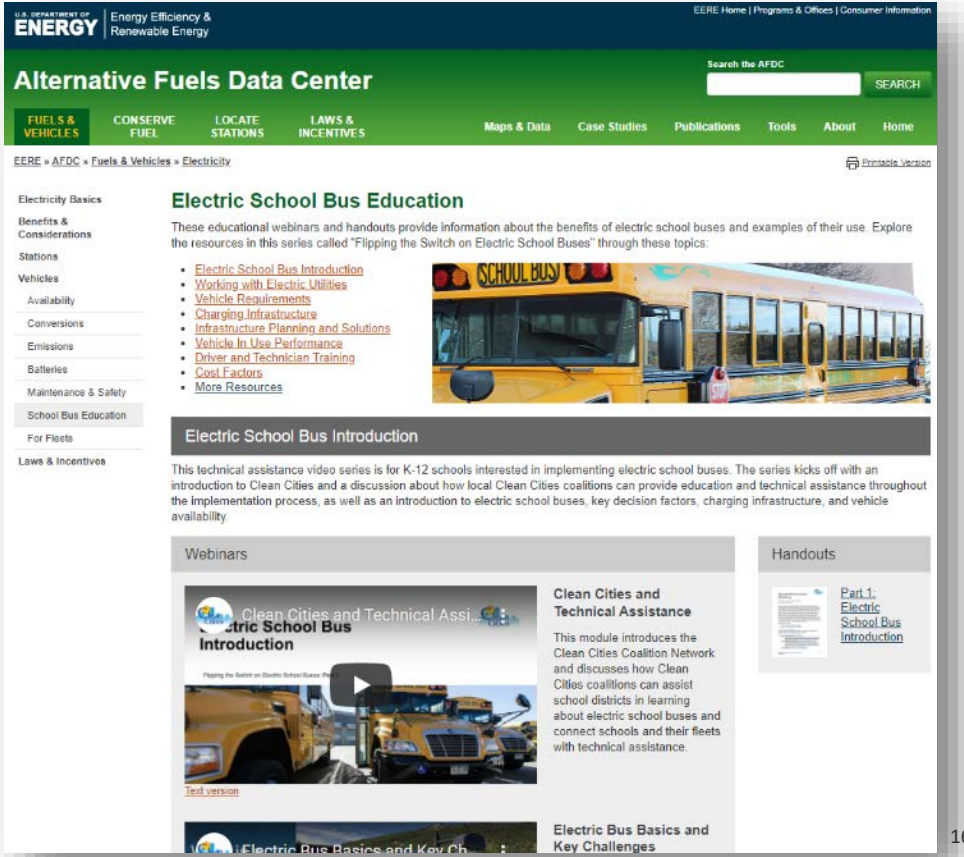
Electric School Bus Education

Flipping the Switch on Electric School Buses

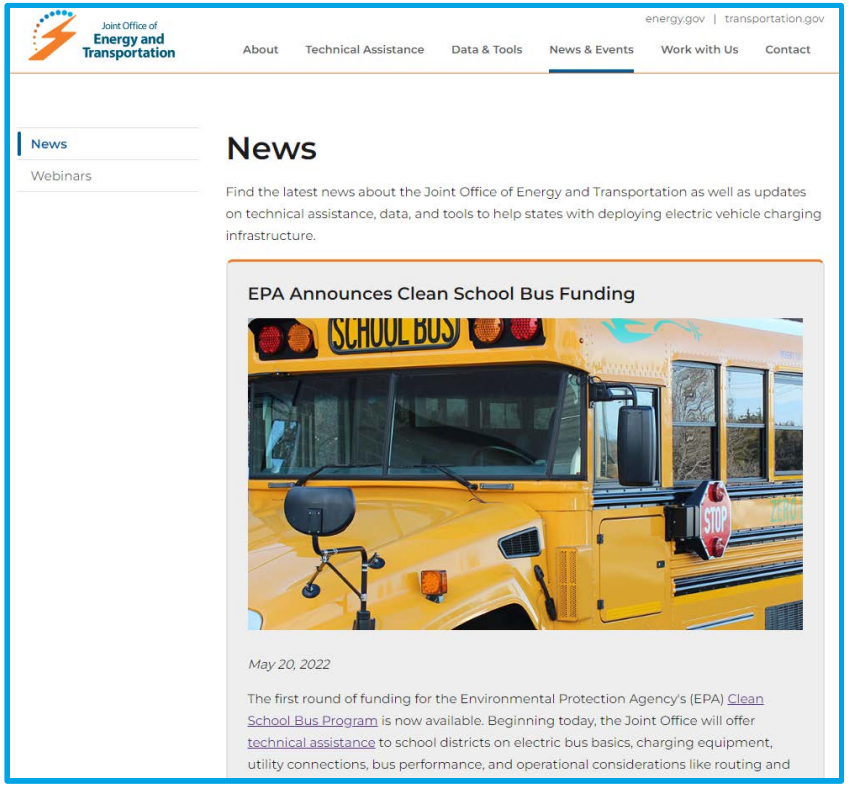
This technical assistance video series is for K-12 schools interested in implementing electric school buses

Watch the videos in order, or pick the topics most interesting or relevant

afdc.energy.gov/electric-school-buses



Electric School Bus Technical Assistance



Clean School Bus Technical Assistance

NREL and the Joint Office of Energy and Transportation are partnering with the U.S. EPA to offer clean school bus technical assistance to school districts

Email: CleanSchoolBusTA@nrel.gov

driveelectric.gov/contact

Electric Vehicle Infrastructure

Technology Overview

Vehicle Acquisition

Route Analysis → Vehicle Specifications/RFP Process → Select Bus OEM → Test Buses & Train Staff

Infrastructure Development

Utility Partner Discussions → Plan & Design → Construction & Installation → Test & Commission

Battery Electric Bus (BEB) Procurement & Infrastructure

Energy vs. Power

Energy Needs (kWh)

- Route requirements determined by:
  - Daily vehicle miles traveled
  - Vehicle operational efficiency
  - Auxiliary loads (heat, AC,…)
  - Environmental impacts

Charger Capabilities (kW)

- Power delivered to vehicle determined by:
  - EVSE type and rating
  - On-board charger
  - On-site electrical capacity

Route Requirements

Duty Cycle

- Distance
- Speed
- Stops
- Terrain

Energy Demand

- Fuel use
- HVAC
- Hours of Operation
- Performance

Driver Style

- Aggressive
- Idling
- Optimize

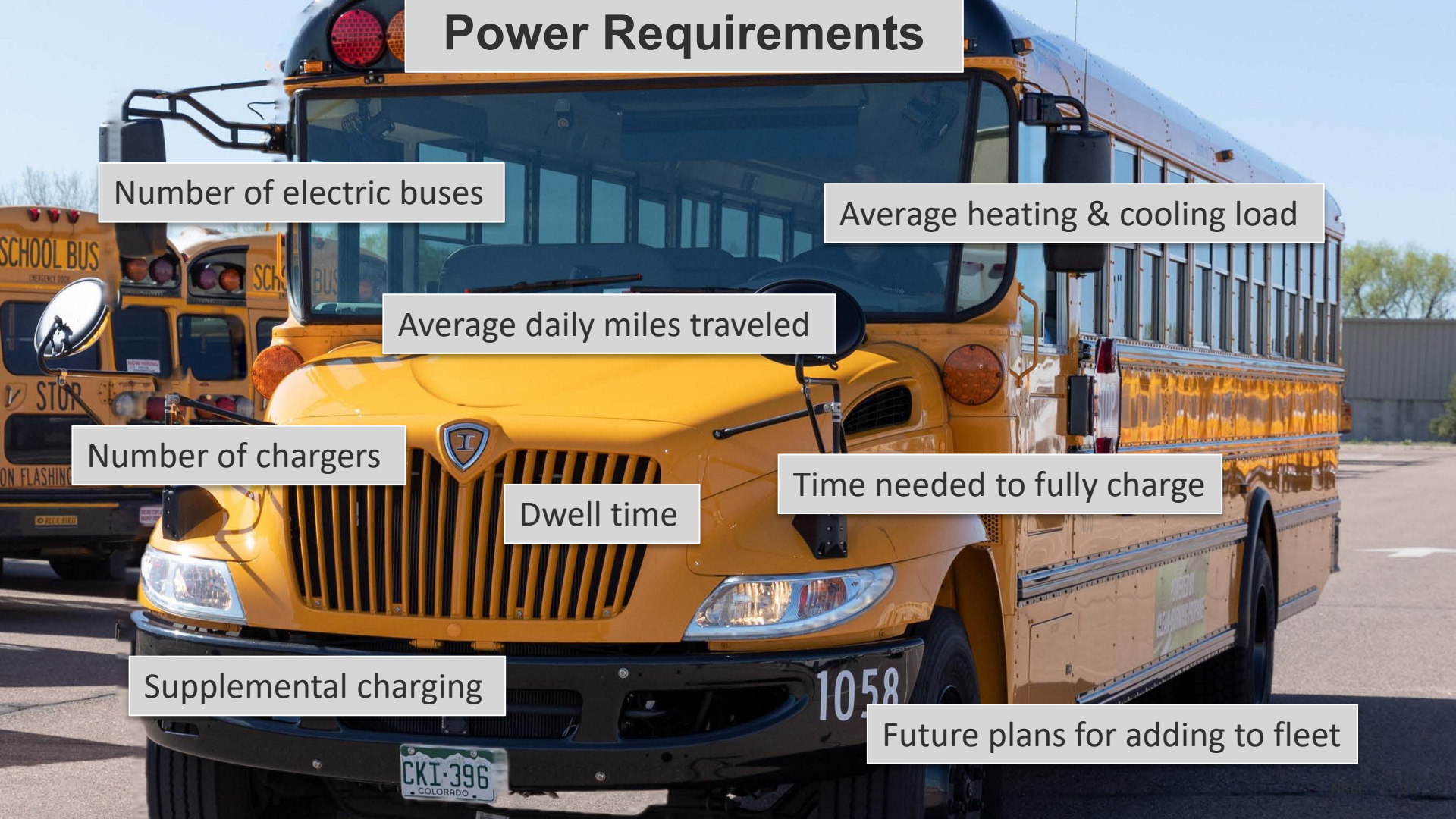
Payload

- Passengers
- Weight

Weather

- HVAC demands
- Road conditions

Power Requirements



- Number of electric buses
- Average heating & cooling load
- Average daily miles traveled
- Number of chargers
- Time needed to fully charge
- Dwell time
- Supplemental charging
- Future plans for adding to fleet

EV Charger = Electric Vehicle Supply Equipment (EVSE)

AC Level 1 – Portable 120 V

AC Level 2 – 208-240 V

DC Fast Charging – 50-1,000 V

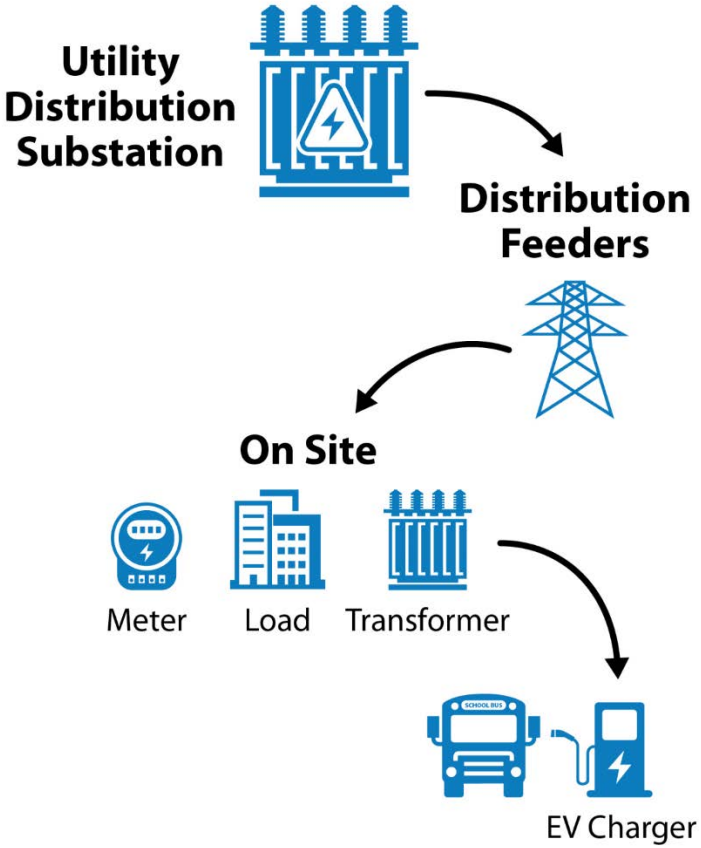
EVSE Unit Costs

Many factors impact the EVSE unit cost per charger (port)

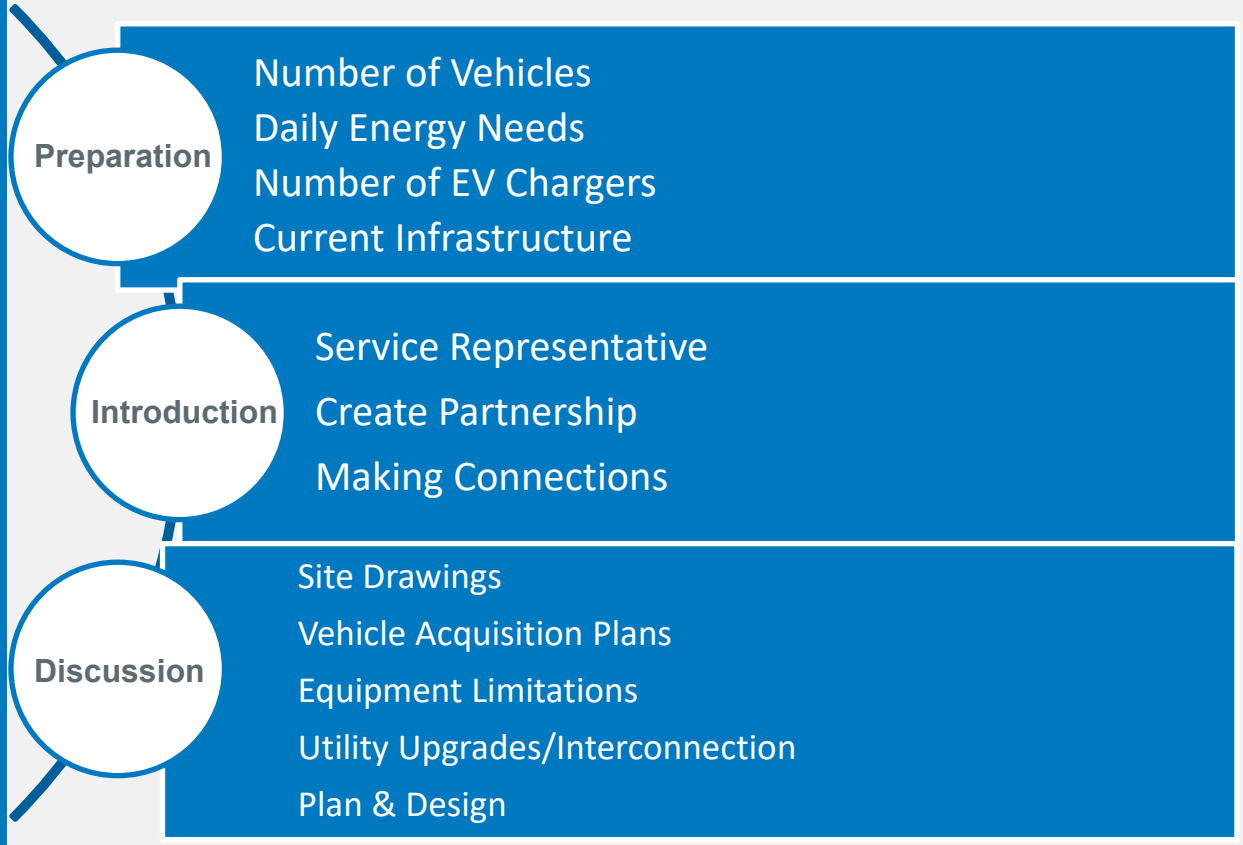
EVSE	Features	Chargers/Unit	Cost/Charger
Level 1	Non-networked	1	$813
Level 1	Non-networked	2	$596
Level 2	Non-networked max 19.2 kW	1	$1,182
Level 2	Non-networked max 19.2 kW	2	$938
Level 2	Networked max 19.2 kW	1	$3,127
Level 2	Networked max 19.2 kW	2	$2,793
DCFC	Networked 50 kW	1	$28,401
DCFC	Networked 150 kW	1	$75,000
DCFC	Networked 350 kW	1	$140,000

- Level 1 units are similarly priced to Level 2 but provide much less power
- Dual-port units are a more economical unit cost per charger
- Network features more than double the cost
- DCFC provide much more power at a much higher cost than Level 2

Power Distribution System



Working with your Utility Partner



Electric Vehicle Infrastructure

Deployment Planning

Implementation Plan for BEB Infrastructure

Vehicles

Choose BEB model for fleet applications

Range, Capacity, Charging

EVSE

Choose EVSE type and quantity

SAE AC Level 2
SAE CCS/CHAdeMO

Utility

Contact utility rep regarding new load

Grid impacts
Transformer/Wiring

Analysis

Determine necessary upgrades

Service Panel
Circuit Breakers

Construction

Install new infrastructure

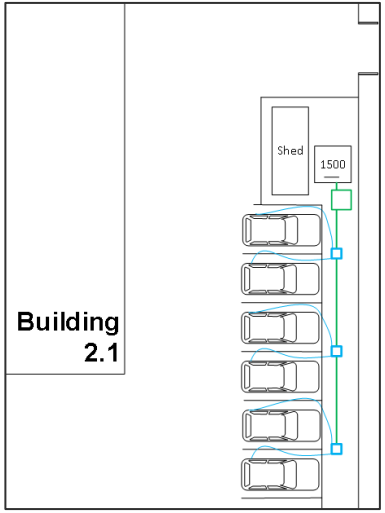
Breakers
Conduit/conductors
EVSE

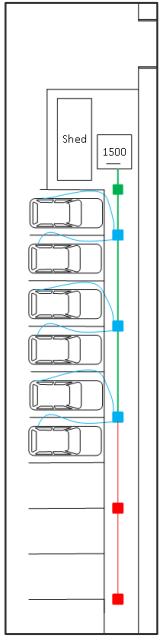
Grid and Facility Considerations

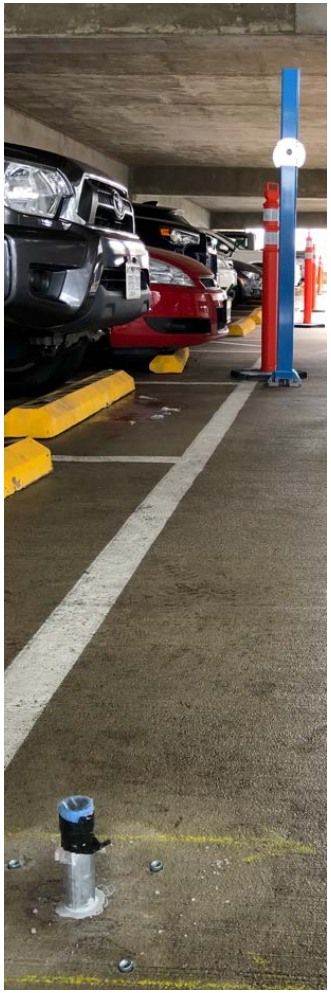
- Site Equipment
  - **Circuit Breaker**
    - Breaker rating 125% of EVSE current per NEC 625
  - **Panel Capacity**
    - Spare breaker positions must be available
  - **Main Breaker**
    - Must be sized for all loads in the service panel
  - **Transformer Capacity**
    - Utility transformer must support total peak demand
- EVSE Requirements
  - **J1772 AC Level 2**
    - Double pole 100 A breaker
    - Up to 19 kW (208-240 V-AC)
  - **J1772 DC CCS**
    - 480 V three-phase power
    - 50–350 kW (50-1,000 V-DC)

Site Layout

- **Determine locations of:**
  - Parking, panel, interconnection
- **Minimize panel to EVSE distance:**
  - Shorter wiring and conduit run
  - Reduce trenching costs (~$100/ft)
- **Consider future expansion:**
  - Install additional wiring/conduit
  - Stub-outs for future expansion
  - Minimize construction costs over time







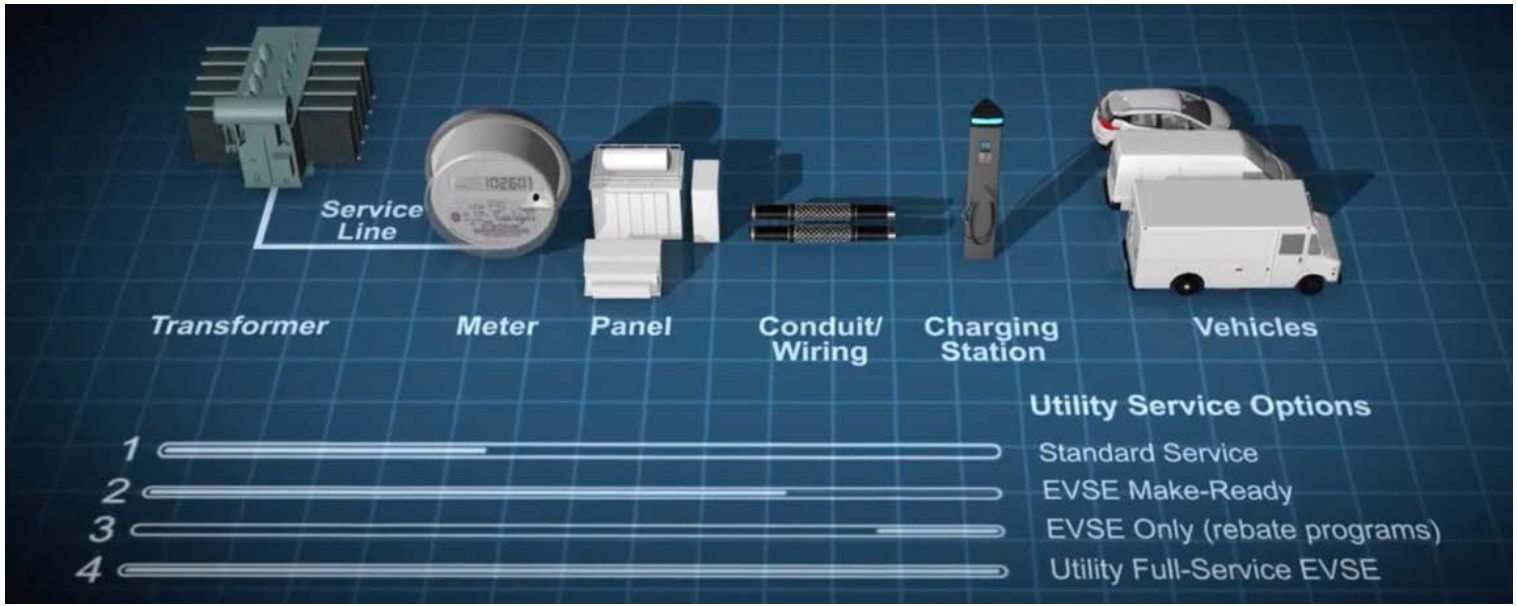
EVSE Installation Costs

- Installation costs are primarily dependent on EVSE type and power.
- L2 pedestal units are common for fleets with a long dwell (8+ hours).
- Installation costs per port decrease as EVSE installations per site increase.

	1 Port/Site	2 Port/Site	3-5 Port/Site	6+ Port/Site
Labor	$1,544	$1,827	$1,647	$1,316
Materials	$1,112	$1,039	$1,272	$874
Permit	$82	$62	$59	$38
Tax	$96	$89	$110	$75
Total	**$2,836**	**$3,020**	**$3,090**	**$2,305**

Grid and Facility Considerations

- Utilities are beginning to offer customers new and innovative service options to meet the energy needs of electric vehicles.
- These different programs can help support the installation of EVSE through infrastructure development or financial support.

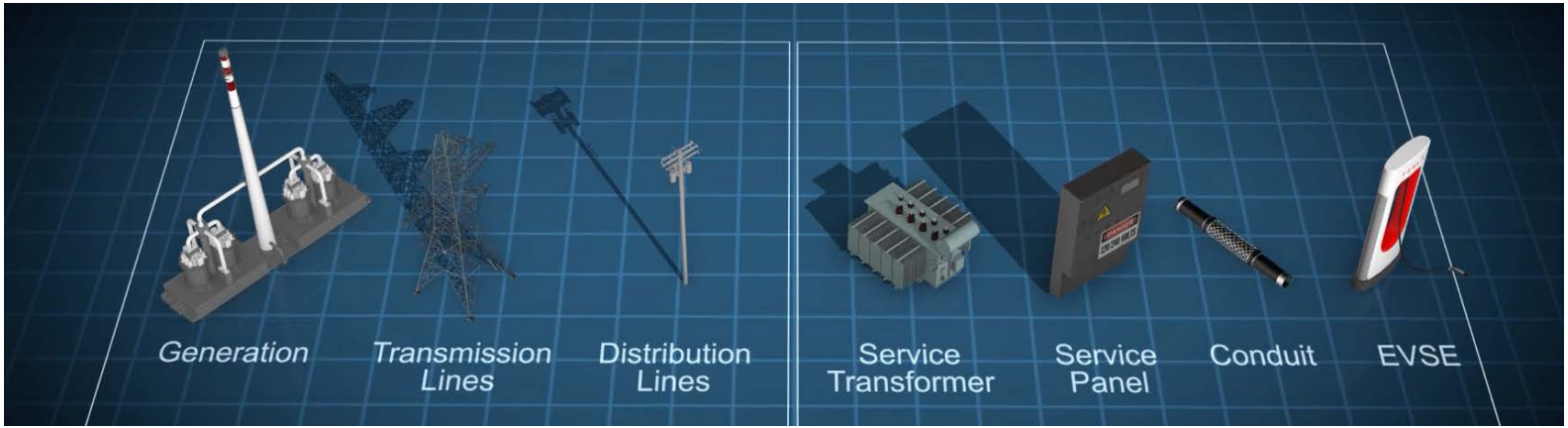


Grid and Facility Considerations

- The electric utility company is most interested in building the grid infrastructure needed to supply the energy your new EVSE will require.

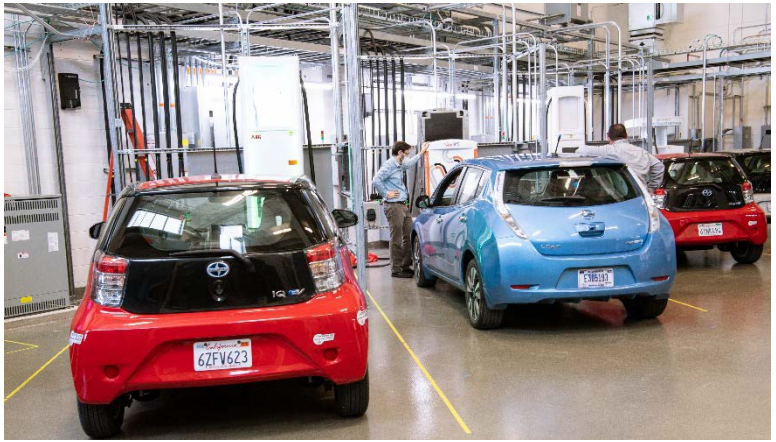
- Grid Upgrade Considerations
  - New Service Line
  - New Interconnection
  - Distribution Transformer Upgrade

- Facility Upgrade Considerations
  - Additional Branch Circuits
  - Service Panel or Main Breaker Upgrade
  - Distribution Transformer Upgrade



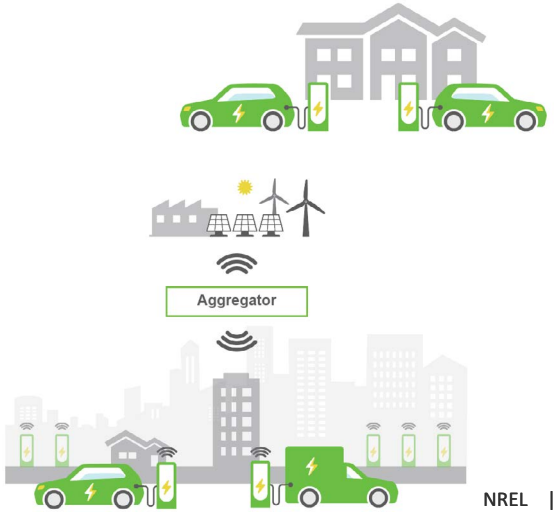
Managed Charging Solutions

How to mitigate equipment upgrades and reduce the cost to charge



NREL – ESIF Vehicles Laboratory – Testing 300kw+ XFC Stations

- **Equipment upgrade mitigation**
  - Set a power ceiling for site-wide EVSE and coordinate charging to reduce equipment upgrades.
- **Reduce electricity costs**
  - Shift EV charging to periods with lower TOU rates
  - Coordinate EV charging loads to reduce peak demand

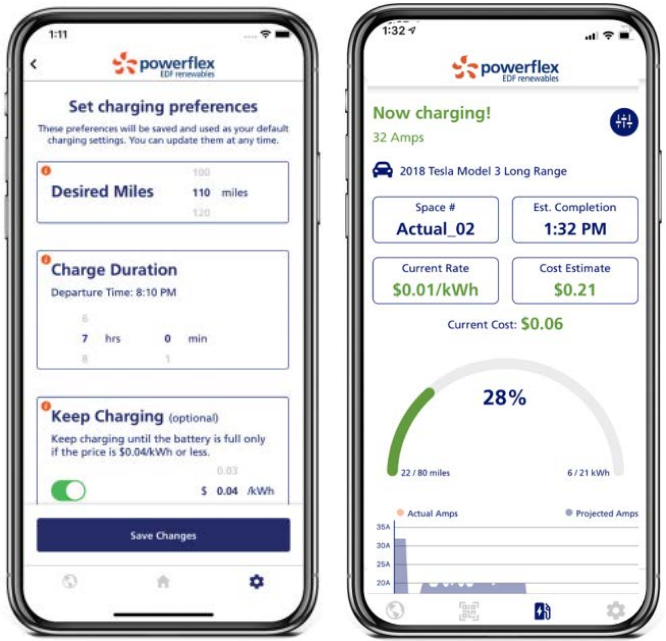


NREL Managed Charging Solution

- **NREL garage workplace and fleet charging installations**
  - 108 Level 2 EVSE with total charging capacity of 720 kW!
  - Total EVSE power exceeds transformer capacity ($$$)
  - Charging peak could increase demand charges

- **Managed charging solution**
  - Drivers input desired mileage and dwell
  - Energy need and charging duration calculated
  - Monitor building loads and PV generation
  - Shift charging away from net building peak
  - Power ceiling prevents overload equipment

NREL Parking Garage – 108 Level 2 charging ports

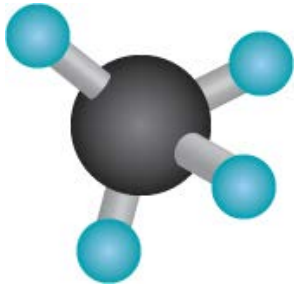


Propane & Natural Gas Infrastructure

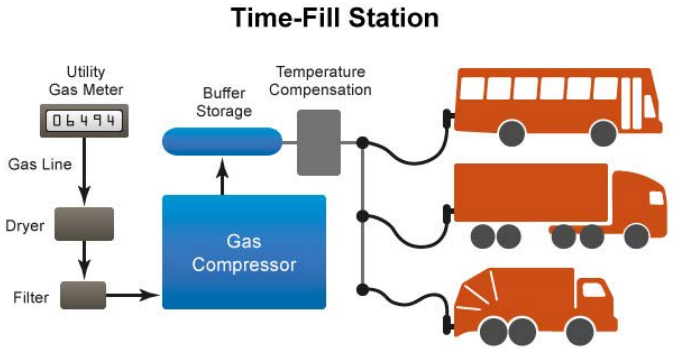
Technology Overview

What is Natural Gas: Natural Gas Properties

- Mixture of hydrocarbons, largely methane (CH_4)
- High octane rating
- High ignition temperature: 1,000–1,100° F
- Available as Compressed Natural Gas (CNG) and LNG
- RNG is essentially biogas processed to purity standards, like conventional natural gas

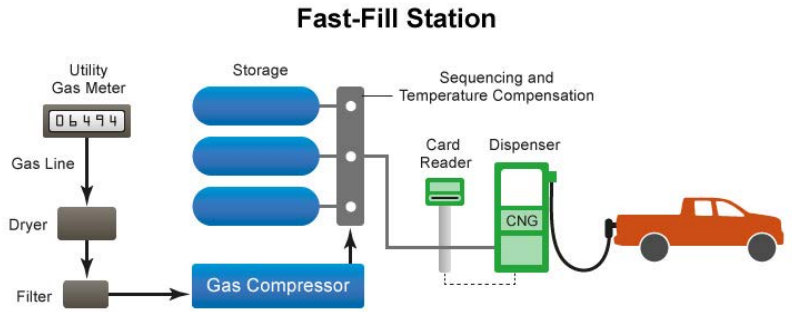


Infrastructure: CNG Fueling



- Good for centrally based fleets with consistent schedules
- CNG is dispensed slowly, often overnight
- Lower cost investment

- Fueling in minutes
- Necessary for public access
- Good for vehicles with little downtime



More Information: AFDC CNG Fueling Stations, http://www.afdc.energy.gov/fuels/natural_gas_cng_stations.html

CNG Station Cost

Size	Approx. Fuel Use	Cost*
Small Station	100–200 gge/day	Fast-fill: **$450K–$600K** (15–25 delivery vans) Time-fill: **$250K–$500K** (5–10 refuse trucks; 10–20 school buses)
Medium Station	500–800 gge/day	Fast-fill: **$750K–$900K** (50–80 light/medium duty vehicles) Time-fill: **$550K–$850K** (25–40 refuse trucks; 50–80 school buses)
Large Station	1,500–2,000 gge/day	Fast-fill: **$1.2M–$1.5M**

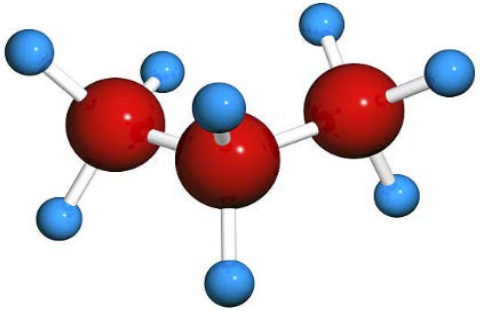
Private time-fill CNG station. *Greater Long Island Clean Cities*

Public fast-fill CNG station. *ANGI*

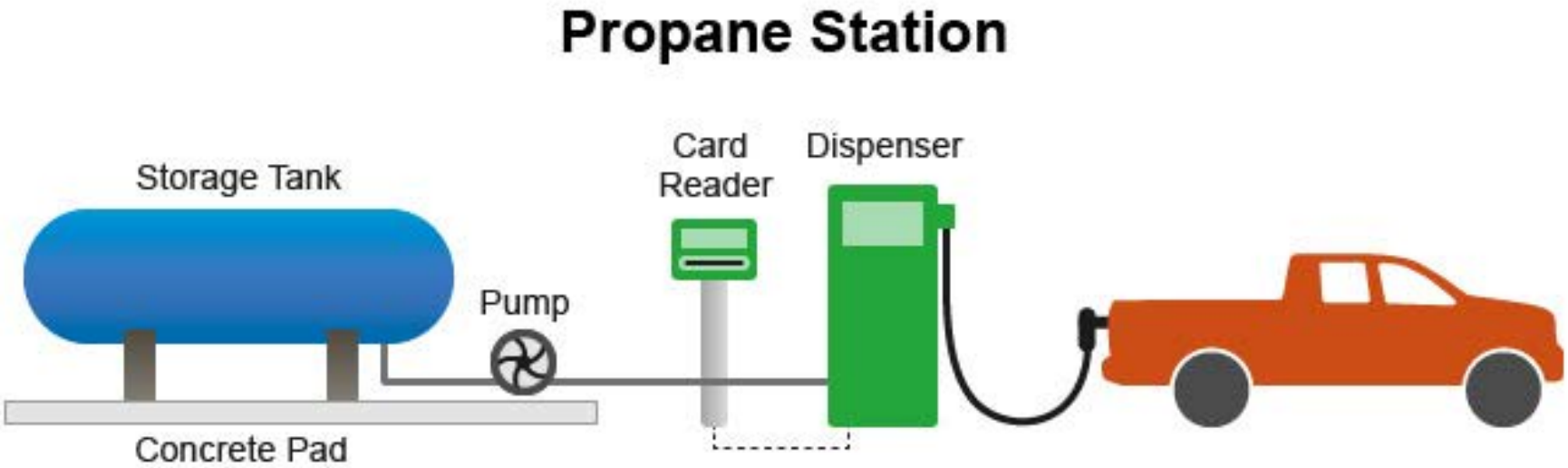
https://afdc.energy.gov/files/u/publication/cng_infrastructure_costs.pdf

What is Propane: Propane Properties

- Also known as:
  - LPG
  - Propane Autogas
- Three-carbon alkane gas (C_3H_8)
- Colorless, odorless, non-toxic
- Stored at about 150 psi as a liquid
- Renewable propane is a non-fossil fuel that is produced from 100% renewable raw materials



Infrastructure: Propane Fueling



Propane Station Costs

Tank (gal.)	Approx. Fuel Use*	Cost
Small 1,000	100–400 gal/day	**$45K–$60K** (Leasing Initial Cost: $3K-$10K)
Medium 18,000	900–2,400 gal/day	**$150K–$220K** (Leasing Initial Cost $15K-$50K)
Large 30,000	900–3,000 gal/day	**$225K–$300K** (Leasing Initial Cost: $15K-$50K)

*Daily fuel use can vary substantially; refills are scheduled to meet station needs.
https://afdc.energy.gov/files/u/publication/propane_costs.pdf

Skid-mounted 1,000-gallon storage tank and dispenser. *Blossman Gas, Inc.*

18,000 Fuel tank with dual two hose dispensers. *Adams 12 School district*

Useful Links

Clean Cities	cleancities.energy.gov
Alternative Fuels Data Center	afdc.energy.gov
“Flipping the Switch” Educational Series	afdc.energy.gov/electric-school-buses
Clean School Bus Technical Assistance	DriveElectric.gov/bus CleansShoolBusTA@nrel.gov

Q&A

www.nrel.gov