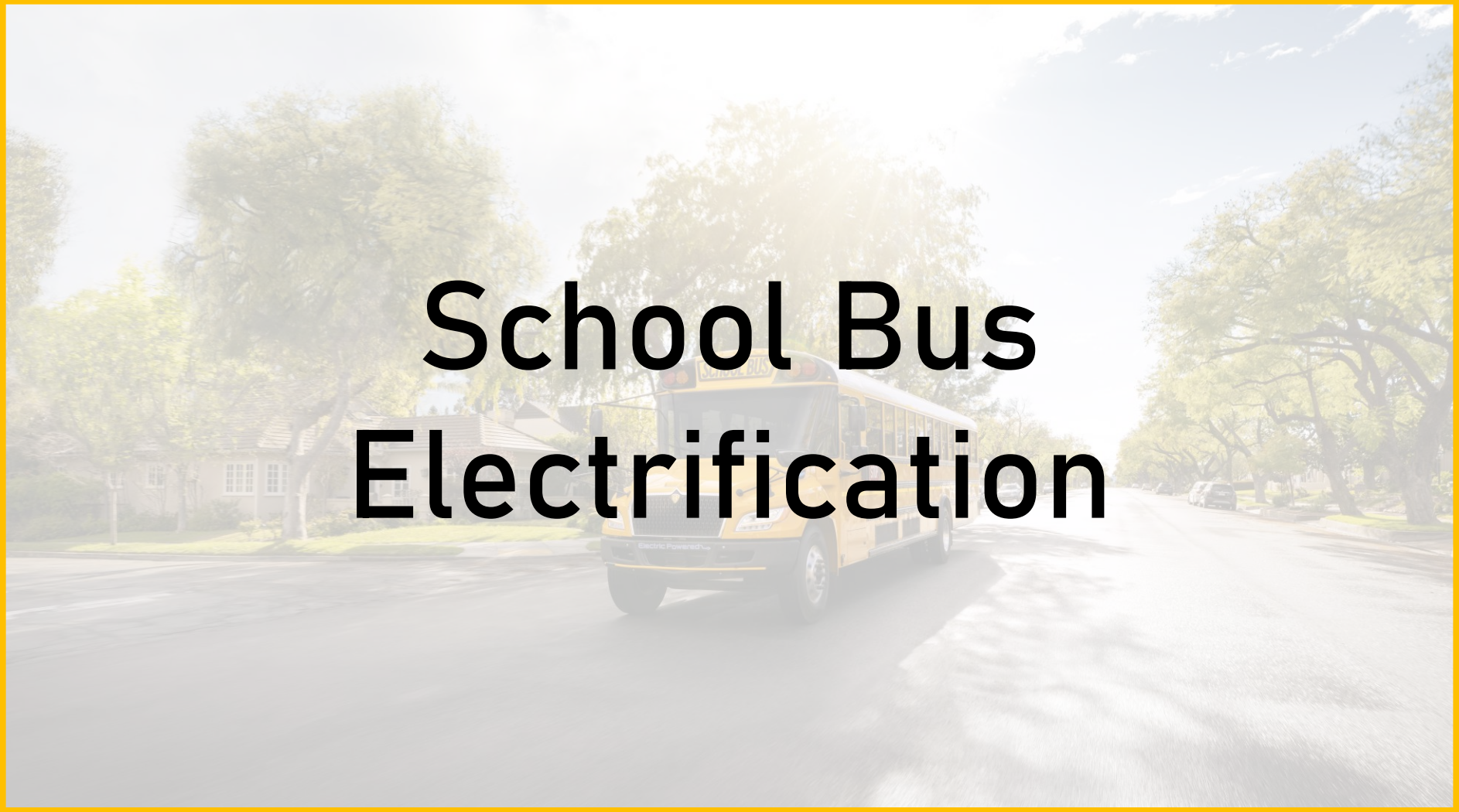


School Bus Electrification

Updated 07-2023

LEONARD Bus Sales Inc

Leonard Bus Sales

- Dedicated to supporting New York's school transportation family for nearly 60 years.
- We continually seek out ways to better support and make it easy for our partners.
- We believe that you know what works best for your operation.
- We provide fact driven materials and training to help you make the best possible decision for your operation.
- We provide best-in-class service and support for your operation, regardless of powertrain.

Our Buses

LEONARD Bus Sales Inc

GreenPower MOTOR COMPANY

New Terms

- Regenerative Braking
  - Power produced by spinning wheels while coasting that is fed back into the batteries to regenerate power.
- Level II and DCFC
  - Available charging cable types
  - DC Fast Charge
- Vehicle-to-Grid Ready (V2G)
  - The ability to use stored battery power and feed it back to the power grid.
- ICE
  - Internal Combustion Engine

Type C Comparison

	IC Bus	Thomas Built Buses	Blue Bird Bus	Lion Bus
Model Name	eCE	Jouley C2	Electric Vision	LionC
Bus Body Width	96”	96”	96”	96” or 102”
Max GVWR	35,000 lbs. Approximately 23,000 lbs., Unladen Weight	33,000 lbs.	33,000 lbs.	31,000 lbs.
Estimated Max Range	Up to 200 Miles	Up to 138 Miles	Up to 130 Miles	Up to 125 Miles
Capacity Options	Up to 77	Up to 81	Up to 77	Up to 77
Tire Size	11R22.5	11R22.5	11R22.5	11R22.5
Electric Motor	Sumo MD – Dana TM4	Proterra ProDrive	Sumo MD – Dana TM4	Sumo MD – Dana TM4
Transmission	None – Direct Drive	Proterra – 2 Speed	None – Direct Drive	None – Direct Drive
Regenerative Braking	Yes – 3 Levels	Yes – 2 Levels	Yes – 1 Level	Yes
Battery Type	Lithium Ion	Lithium Ion	Lithium Ion	Lithium Ion
Charging Ability	AC Level 2	AC Level 2 NOT Available	AC Level 2	AC Level 2
	DC Level 3 (Fast Charge)	DC Level 3 (Fast Charge)	DC Level 3 (Fast Charge)	DC Level 3 (Fast Charge)
Braking	Air Disc - Standard	Air Disc - Standard	Air Drum - Standard	Hydraulic Disc - Standard
Service At	**Leonard Bus Sales**	Thomas Bus Dealer	Cummins Service Center	H.K Truck Center (New Jersey)

Type D Comparison

	GreenPower	Blue Bird Bus	BYD/RIDE
Model Name	BEAST	All American	Type D School Bus
Bus Body Width	102”	96”	101.5”
Max GVWR	42,990 lbs. Approximately 29,200 lbs., Unladen Weight	36,200 lbs.	39,153 lbs. Approximately 29,880 lbs., Unladen Weight
Estimated Max Range	Up to 140 Miles	Up to 120 Miles	Up to 155 Miles
Capacity Options	Up to 84	Up to 84	Up to 84
Tire Size	11R22.5	11R22.5	305/70 R22.5
Electric Motor	Dana TM4 Sumo	Dana TM4 Sumo	In-Wheel Drive Axle
Transmission	None – Direct Drive	None – Direct Drive	None – Direct Drive
Regenerative Braking	Yes – 1 Level	Yes – 1 Level	Unknown
Battery Type	Lithium Ion	Lithium Ion	Lithium Ion
Charging Ability	AC Level 2	AC Level 2	AC Level 2
	DC Level 3 (Fast Charge)	DC Level 3 (Fast Charge)	DC Level 3 (Fast Charge)
Braking	Air Disc	Air Disc or Drum	Air Disc
Service At	**Leonard Bus Sales**	Cummins	Unknown

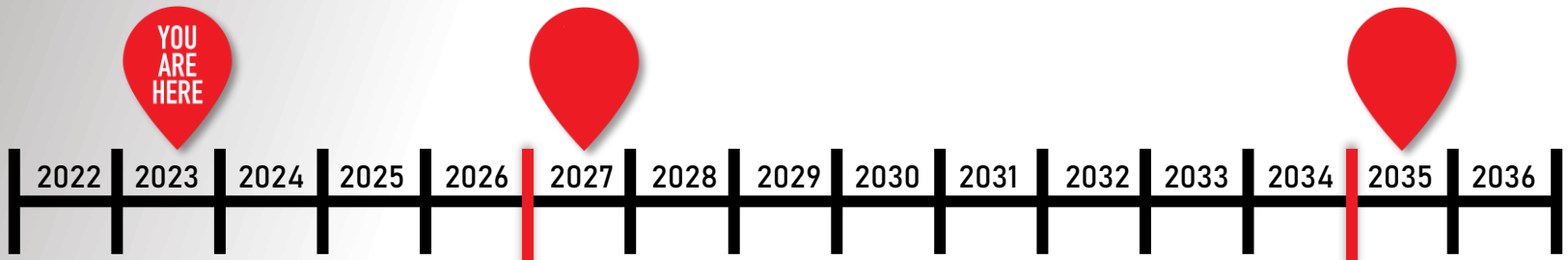
Type A Comparison

	GreenPower	Trans Tech	Collins Bus	Blue Bird Bus
Model Name	Nano BEAST	SST	DE516F	Micro Bird
Chassis	GreenPower	Ford E450	Ford E450	Ford E450
Bus Body Width	92”	96”	96”	96”
Max GVWR	14,330 lbs.	14,500 lbs.	14,500 lbs.	14,500 lbs.
Estimated Max Range	150 Miles	105 Miles at Max GVWR	105 Miles at Max GVWR	105 Miles at Max GVWR
Capacity Options	Up to 24 Passengers	Up to 20 Passengers	Up to 30 Passengers	Up to 30 Passengers
Transmission	None – Direct Drive	Yes – Two Speed	Yes – Two Speed	Yes – Two Speed
Regenerative Braking	Yes - Standard	Yes - Standard	Yes - Standard	Yes - Standard
Battery Type	Lithium Ion	Lithium Ion	Lithium Ion	Lithium Ion
Charging Ability	AC Level 2	AC Level 2	AC Level 2	AC Level 2
	DC Level 3 (Fast Charge)	DC Level 3 (Fast Charge)	DC Level 3 (Fast Charge)	DC Level 3 (Fast Charge)
Service At	**Leonard Bus Sales**	Leonard Bus Sales Ford Dealer Motiv Power Systems	Selling Dealer Ford Dealer Motiv Power Systems	Selling Dealer Ford Dealer Motiv Power Systems

Why the Push for EV?

- Heightened climate awareness and community expectations
- Able to leverage renewable and carbon neutral energy sources
- 500,000 school buses on the road – the largest public transportation fleet in the United States
- Predictable routes with a fixed home base
- Like propane, gas, CNG, and diesel, there is a place for electric
- Thousands of gallons of fuel saved annually
- Lower emissions at the tailpipe
  - Diesel, propane, gas, and CNG continue to be clean burning fuel types and pose fewer health risks than older buses

Legislation

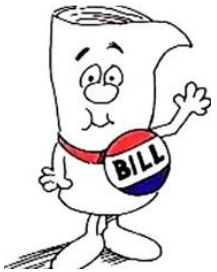


All New NY School bus purchases are to be zero-emission by July 1st, 2027

All NY school buses are to be zero-emission by July 1st, 2035

This includes all vehicles used to transport students:

- Minivans (Type O)
- Small Buses (Type A)
- Large Buses (Type C & D)



Legislation

	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
NYS Fiscal Year 2023 Mandate											
All school vehicles sold in the given calendar year.			Zero Emission Electric Only								
Advanced Clean Truck Regulations – OEM required zero emission vehicle sales per model year.											
Class 2B-3 8,501 – 14,000 lbs. GVWR	7%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%
Class 4-8 (Trucks, Buses) 14,001+ lbs. GVWR	11%	13%	20%	30%	40%	50%	55%	60%	65%	70%	75%
DEC Part 218 – Heavy Duty Omnibus – NOx Standards that apply to all engines used in heavy duty vehicles over 14,000 lbs. GVWR per model year.											
FTP Cycle (g/bhp-hr.)		0.05	0.02								
RMC – Set Cycle (g/bhp-hr.)		0.05	0.02								
Low-Load Cycle (g/bhp-hr.)		0.20	0.05								

Terms:

GVWR – Gross Vehicle Weight Rating: The maximum possible weight of a fully loaded vehicle that includes all passengers.

Class 2B-3: Typically, mini vans, pickup trucks, local delivery vehicles

Class 4-8: Typically, large delivery trucks, buses, construction vehicles, etc.

g/bhp-hr.: Grams per brake-horsepower hour

Maintenance

- Maintenance savings – fewer unpredictable expenses

Diesel	Electric
Oil Maintenance	No Engine Oil
Fuel System	No Fuel System
Transmission	No Transmission
Exhaust System	No Turbo, EGR, or Injectors
Air Filter	No Air Filter
DPF and DEF Systems	No Aftertreatment

Maintenance

- Maintenance – What stays the same?
  - Tire and Suspension Maintenance
  - Bus Body Maintenance
  - Brake Replacement and Maintenance
  - Air System Maintenance
  - Lubrication/Greasing Practices
  - Interior

The Hold Ups

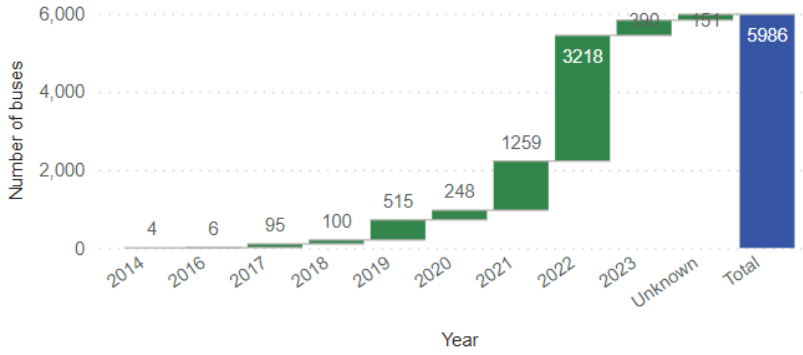
- 25-30% decreased range in cold climates
- May not work on all routes
  - May need to redesign existing routes from scratch
  - May require additional fuel types until technology evolves
- Limited public charging network
  - Not suitable for all sports and/or field trips at this time
- Power grid capabilities
- Higher purchase price
  - $400,000+ vs. $150,000 for diesel
- Grants often geared toward older fleets
  - Typically, 2009 and older

Current Standing

- Committed Electric School Buses (As of June 22, 2023)
  - An electric school bus is considered “Committed” when an operator has been awarded funding to purchase it or has made a formal agreement for purchase. This includes buses already delivered and/or in operation.

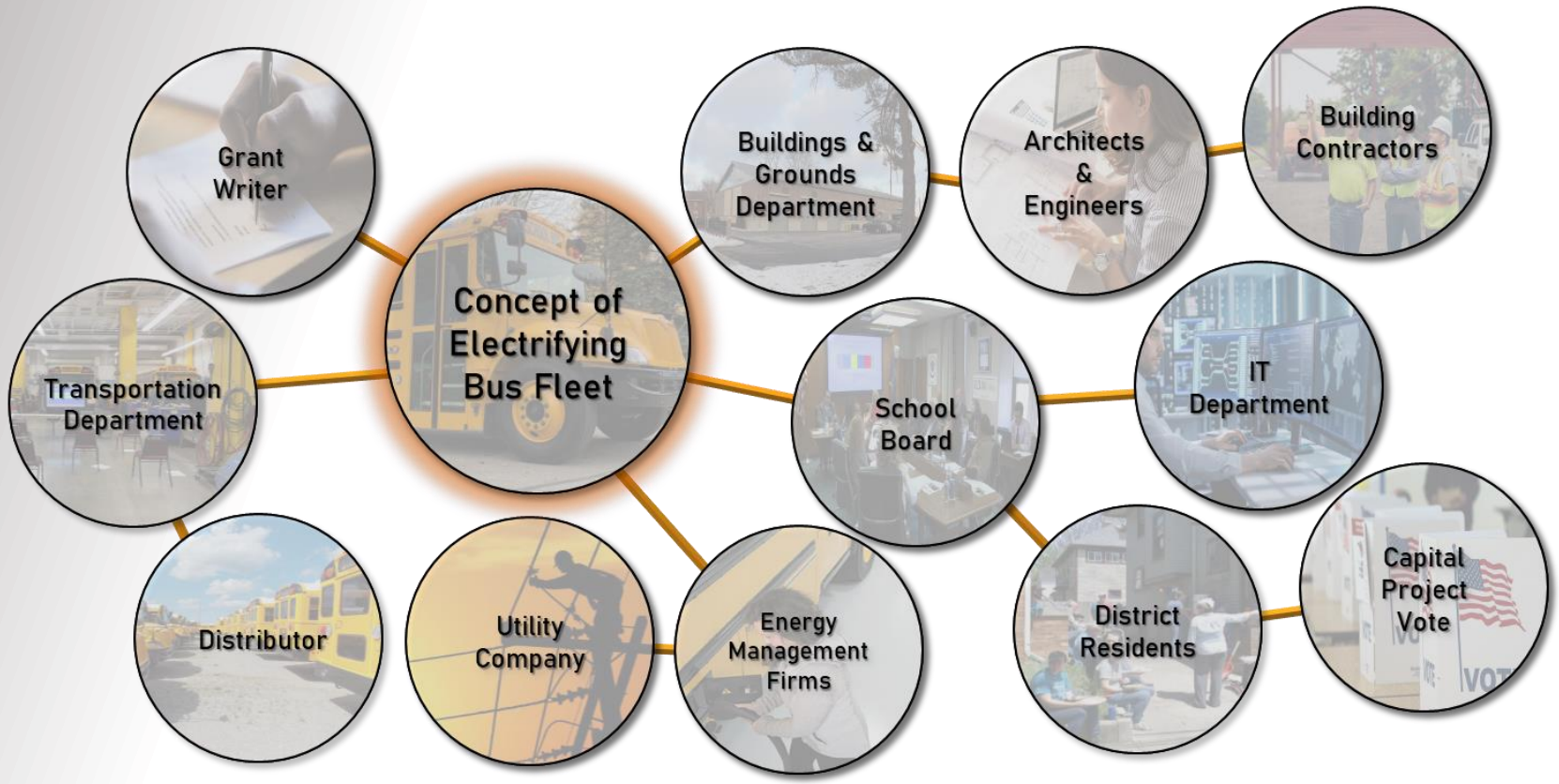
Nationwide	Number of Buses	Total Districts and Fleet Operators	States and US Territories
Committed	5,896	909	55
On the Road Today	1,134	301	39

New York State	Number of Buses
Committed	304
On the Road Today	30



Before the Bus

- The initial electrification of school bus fleets will initially involve a greater number of people and steps than a typical bus purchase.



Before the Bus – Planning

LEONARD Bus Sales Inc

Year 1 – Exploration and Preparation

- Interest in Electric Bus
- Route Consultation
- Charging Infrastructure Consultation
- Grant and Incentive Procurement
- Complete Financing Package

*Not necessarily in this order**

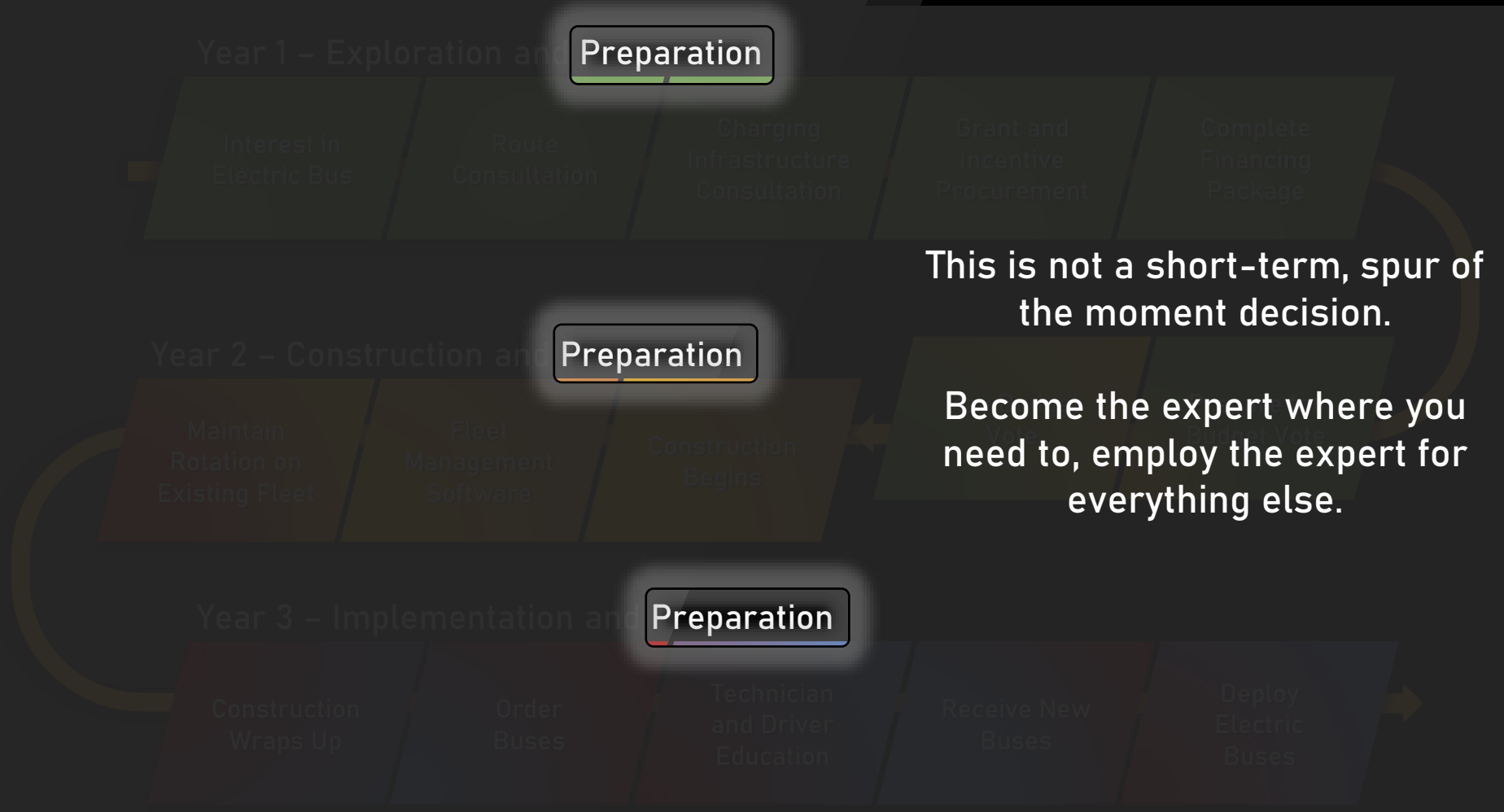
Year 2 – Construction and Preparation

- Prepare for Budget Vote
- May Budget Vote
- Construction Begins
- Launch Fleet Management Software
- Maintain Rotation on Existing Fleet

Year 3 – Implementation and Preparation

- Construction Wraps Up
- Order Buses
- Technician and Driver Education
- Receive New Buses
- Deploy Electric Buses

Before the Bus – Planning



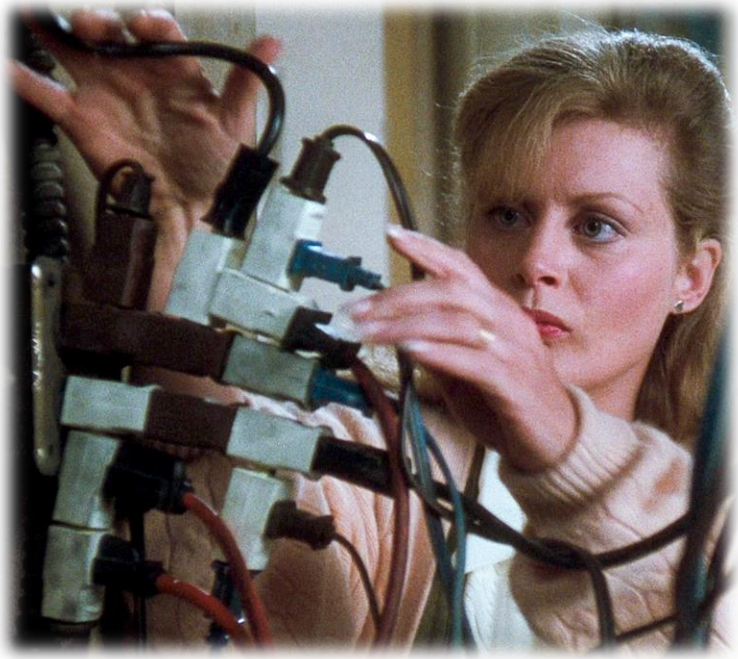
This is not a short-term, spur of the moment decision.

Become the expert where you need to, employ the expert for everything else.

Before the Bus – Planning

FACILITY & GRID CAPACITY

- What is the capacity of your current facility and electrical grid?
  - Can the grid as a whole handle the additional power draw?
  - If not, what is involved with adding feeds?
- In terms that we're familiar with:
  - A circuit breaker can only handle so much power draw
  - Plugging too many appliances in at once causes a breaker to trip
  - The only way to gain additional power is to add a circuit

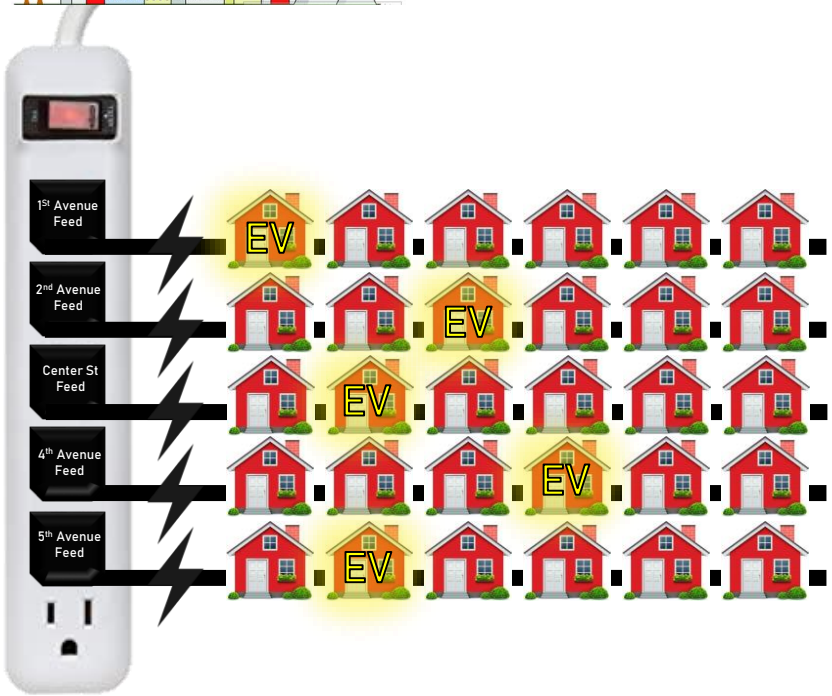


Before the Bus – Planning

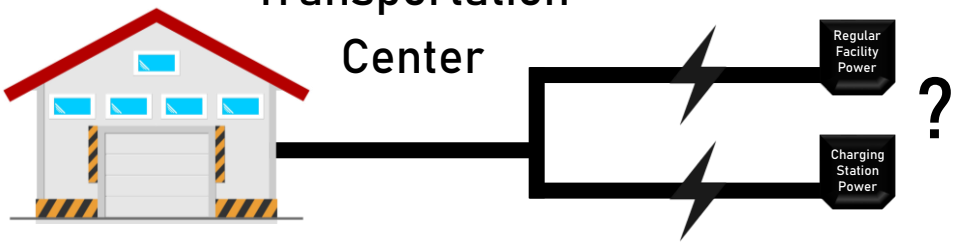
FACILITY & GRID CAPACITY

- The substation feeding your area does not have an unlimited capacity
- Upgrades will be required in almost every case
- Costs will vary greatly, depending on current capacity and distance to the substation

Distribution Substation



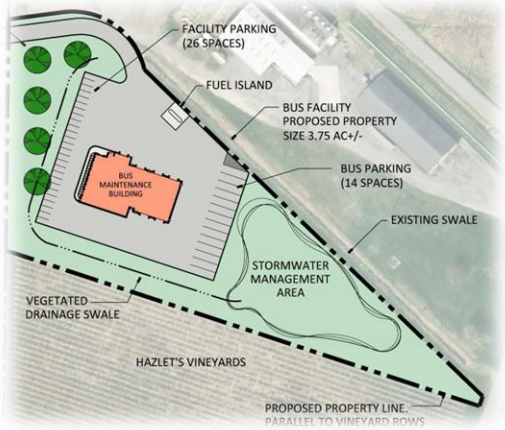
Transportation Center

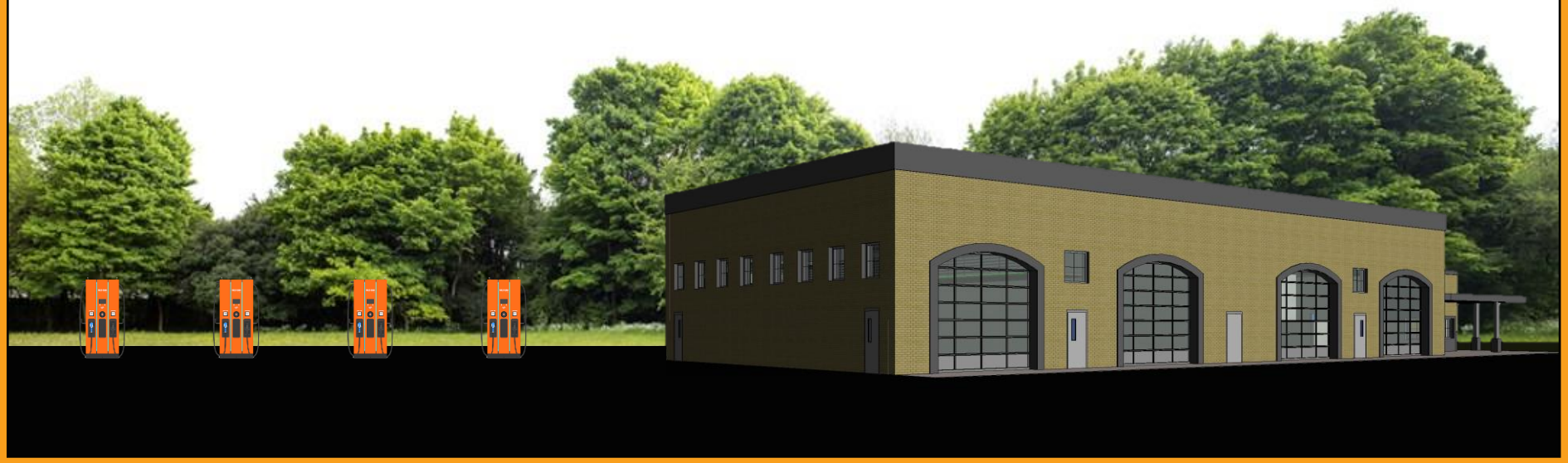


Before the Bus - Planning

FUTURE FACILITY CONSIDERATIONS

- Future-proof your district during the planning phase:
  - Expect electric to be part of your future in some capacity
  - Create provisions for future infrastructure
    - i.e., Conduit, sidewalks, islands, etc.





Before the Bus - Planning

FUTURE FACILITY CONSIDERATIONS

- Future-proof your district during the planning phase:
- Remember to include other locations within your district:
  - Athletic fields
  - Event centers

LEONARD
Bus Sales Inc

Understanding Charging Systems

Charging Systems

CHARGING FUNDAMENTALS

New Terms

- Parallel Charging:
  - Charging of multiple buses at the same time
  - Uses more power while in use
- Sequential Charging:
  - Charging one bus, then charging another
  - Uses less power while in use
- DCFC:
  - Level 3 Fast Charging

Vehicle-to-Grid

CHARGING FUNDAMENTALS

LEONARD Bus Sales Inc

Vehicle-to-Grid (V2G)

- Allows stored power in vehicle batteries to be sold back to the grid in times of increased demand.
- Use Caution:
  - Most batteries will come with a maximum throughput associated with the warranty.
  - Throughput is any power put into and taken out of the battery.
  - Selling power back to the grid will count as throughput and could decrease your warranty period significantly if not managed properly.
  - Selling power back to the grid will discharge the battery and require a new charge cycle to replenish.

Charging Systems

CHARGING FUNDAMENTALS

- Society of Automotive Engineers (SAE) standard charger
- Will physically connect to any make/model of EV School Bus
- Charger shown here is capable of both AC and DC charging.
- Leonard Bus Sales can help determine and fulfill all your charging hardware and software needs as part of the bus quoting process.

Charging Systems

CHARGING FAST FACTS

LEONARD Bus Sales Inc

Hair Dryer on High Heat
1,500 watts
1.5 kWh for 1 hour

Maytag® Dryer
2,100 watts
2.1 kWh for 1 hour

Average Standard Range Tesla
25,000 watts
25 kWh per 100 miles

Electric School Bus
210,000 watts
210 kWh per ~135 miles

125 kW
Maximum
DC charging speed

75%
of charging issues
can be resolved remotely

609V
IC Bus® vehicle
architecture

700V
Minimum charging
voltage

25 ft.
Cable length recommended
for dual output charger

16 ft.
Available for single
output charger

OR **210 kWh**
315 kWh
BEV Battery capacity

20% TO **95%**
Charge Time
IN
1.5 Hours

WITH A **125 kW** Charger*

*20% to 95% state of charge, room temperature, current production CATL LFP Batteries

Charging Systems

CHARGING FUNDAMENTALS

Level 1

- Provides charging through a 120V AC plug and does not require installation of additional charging equipment.
- Not suitable for commercial vehicles such as buses.

Level 2

- Provides charging through a 240V (Residential) or 208V (Commercial) plug and requires installation of additional charging equipment.
- Commercial Charger
- 19.2kW
- Typically, 19.2kW for Commercial
- Suitable for Overnight and Mid-Day Charging in Many Cases.
- Will Charge an electric school bus.

Charging Systems

CHARGING FUNDAMENTALS

Level 3

- DC Fast Charge: Provides charging through 208-600V AC input and requires specialized equipment to be installed at your vehicle location.
- Commercial Charger
- Multiple Power Options
- 24kW to 350 kW
- Full Charge in Less Than one Hour
- Will Charge an Electric CE

This is the most expensive charger but will be needed in some cases.

Before the Bus - Planning

ENERGY SUPPLIER

Utility Resources

- Below you can access each company's EV Make-Ready Program landing pages where customers can find more information and resources to apply for the MRP.
- If you have questions or need assistance with the MRP, please email your utility at the correct address below.

Utility	Email	Website
Central Hudson	EVMakeready@cenhud.com	https://tinyurl.com/ych7zhzw
Con Edison	EVMRP@coned.com	https://tinyurl.com/yck78p5v
National Grid	EVNationalGridUNY@nationalgrid.com	https://tinyurl.com/3xnmehud
NYSEG	EVPrograms@nyseg.com	https://tinyurl.com/ycknfejb
RG&E	EVPrograms@rge.com	https://tinyurl.com/4saf4zmk
Orange and Rockland	ev@oru.com	https://tinyurl.com/yx54995r

Before the Bus - Planning

NYAPT WEBINAR SERIES

LEONARD Bus Sales Inc

- For more information about planning for an EV Fleet, please visit the links below to view the three-part NYAPT Webinar Series presented by Cornice Technology.
  - Part 1: Planning for an Electric Bus Fleet
  - https://vimeo.com/638629580
  - Part 2: Understanding Electric Vehicles and Charging Infrastructure
  - https://vimeo.com/641929212
  - Part 3: Understanding Electricity as a Fuel
  - https://vimeo.com/646044340

CORNICE TECHNOLOGY

Before the Bus – Funding

EPA CLEAN SCHOOL BUS PROGRAM

EPA CLEAN SCHOOL BUS PROGRAM OVERVIEW www.epa.gov/cleanschoolbus

- Total funding of $5 billion over a 5-year time frame starting in 2022 for the replacement of existing school buses with low and zero-emission (ZE) school buses.
  - Round 1 <CLOSED> - The first round of funding in 2022 was in the form of a rebate program for bus replacement and infrastructure. With nearly 2,000 applicants seeking to upgrade their school bus fleets with ZE or clean school buses, the EPA made the decision to nearly double the initially intended funding level for this round from $500M to nearly $1B.
  - **Round 2** <CLOSED> - The second round of which opened in April 2023 was in the form of a narrative grant program intended to award approximately $400M to a total of 25 – 50 large projects across the country. Awards are expected to be announced in November or December.

Before the Bus – Funding

EPA CLEAN SCHOOL BUS PROGRAM

- **Round 3** <NOW OPEN> – The third round of which opened on September 28th, 2023 is in the form of a rebate program for bus replacement and infrastructure, much like round one. Applications are due by January 31st, 2024.
  - The EPA's goal is to award at least $500m toward NEW zero-emission school buses and related infrastructure.
  - Existing vehicle must still be traded, sold, or scrapped to obtain new vehicle.
  - Funding levels have changed and have been reduced. The vehicle and infrastructure monies have merged.
  - Recipients have flexibility to determine the split between funding for the bus itself and the supporting infrastructure.
  - Based on the funding allowed, it appears that the monies will NOT cover the full cost of a vehicle, so infrastructure programs and funding will be separated from the rebate and most projects will need to go though SED for approval for capital programs to install fueling infrastructure.
  - For this round, 60% of funds will be allocated towards priority applicants.
  - Applicant will be required to provide School Board Awareness and Utility Partnership Certifications as part of the application process.

The full program can be found at https://www.epa.gov/cleanschoolbus/clean-school-bus-program-grants.

Before the Bus – Funding

NY SCHOOL BUS INCENTIVE PROGRAM

LEONARD Bus Sales Inc

NY SCHOOL BUS INCENTIVE PROGRAM (NYSBIP) OVERVIEW

- NYSBIP is NYSERDA program that is being funding through the Environmental Bond Act.
  - All applications must be submitted through vehicle dealers on behalf of the fleet owners.
  - The initial program funding for school buses is $100 million.
  - Additional funding is expected to be available for charging infrastructure. This part of the program has not been released yet.
  - Funding amounts will be calculated using a base voucher amount, then adding bonuses and complementary vehicle add-ons. These amounts may change over time and will be updated to reflect market conditions and funding availability.
  - Application period opens 11/29/2023 and will be run on a first-come, first-served basis.
  - Scrapping is NOT required. Eligible vehicles to be scrapped are ICE vehicles with an engine dated (7) years or older than the year of application.
  - NYSBIP is accessible to all public-school districts, regardless of need-status or Disadvantaged Community (DAC) status. Different voucher amounts apply for Priority Districts and non-Priority Districts. Eligibility is determined by the entity and vehicle.

- PLEASE NOTE: Full details of this program have not yet been released.

Electric Bus Acquisition

- Through Leonard Bus Sales and our partnership with Cornice Technology, the bus quote provided by your Transportation Advisor can include the following to simply the ordering and launch process:
  - The bus/buses
  - Charging hardware (Not including sitework to feed power to the hardware)
  - Charging software and plans (For battery charging management, all EVSB's require software)
  - Charger maintenance plans (Serviced by Leonard Bus Sales Technicians)
- To assist in a smooth implementation after the bus quote, Leonard Bus Sales and Cornice Technology can help steer initial discussions toward the appropriate next steps including:
  - Utility coordination and consultation
  - Electrical upgrades and associated expenses
  - Facility/Civil upgrades
  - Contractor bids and award amounts
- Construction may be required as electric vehicles are added to your fleet.

**Note that all construction related expenses must be managed separately and cannot be included on a quote as part of the bus purchase.*

eCE Spec Sheet

- Battery Thermal Management System (BTMS) maintains optimal temperature for range and charging
- 650 volt, 6-phase permanent magnet motor
- State-of-the-art instrument cluster
- Three levels of regenerative braking
- Level II AC and DCFC charging ready
- Peak Power: 335HP
- Continuous Power: 255HP
- Vehicle to grid (V2G) ready

LEONARD Bus Sales Inc

Two battery options offer the longest single-charge range in the industry

Range is approximate and will vary based on the driver, terrain, temperature, and a variety of other factors.

The Bus

IC eCE SPEC SHEET

LEONARD Bus Sales Inc

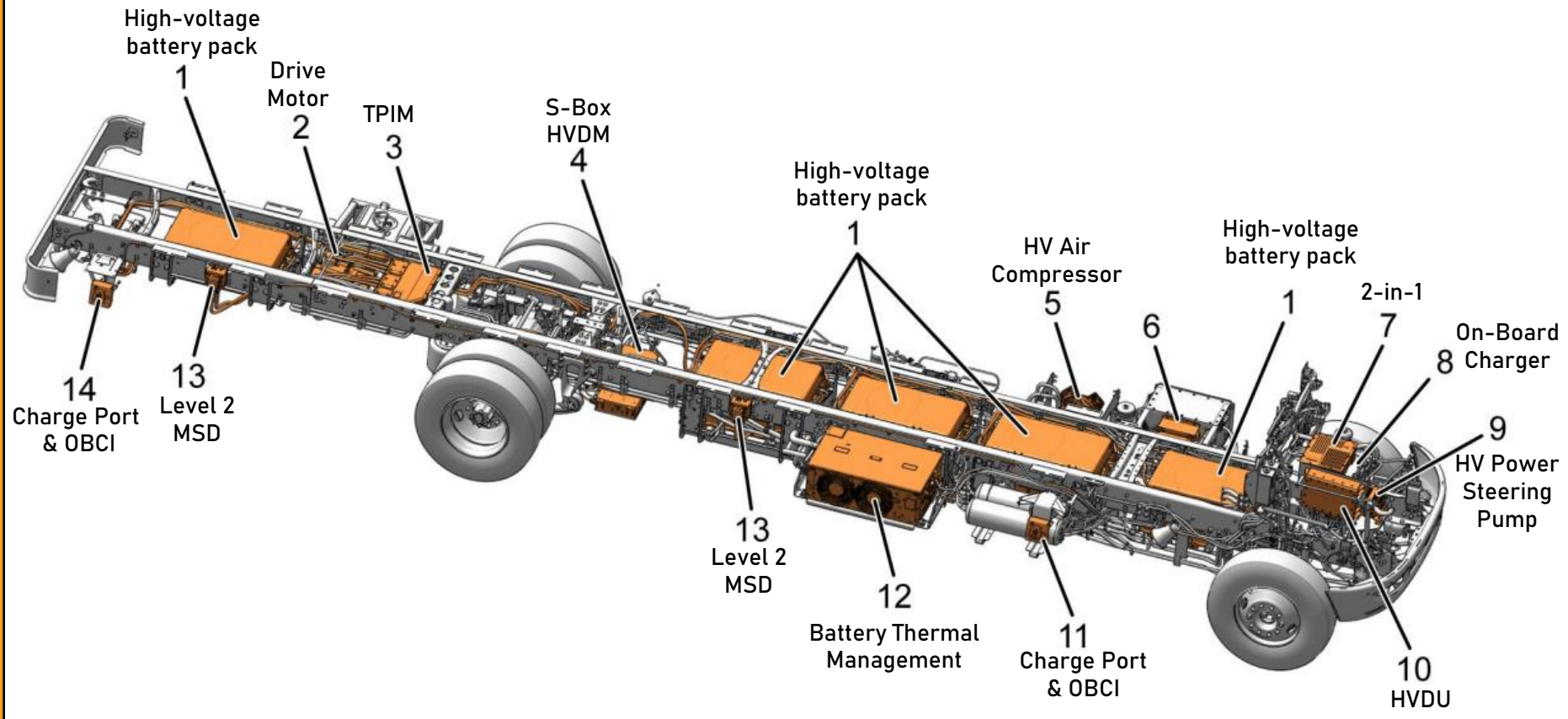
Capacity	**29-70 Passengers** *Floorplan configurations vary based on seat spacing and wheelchair positions.*
Wheelbase Options	**217" - 276"** (Configuration May Vary) *Capacity and battery configuration options are closely related.*
GVWR	**31,000 – 33,000 lbs.** *Electric buses are comparable in weight to a standard bus.*
Safety	**Standard Electronic Stability Control** *Collision Mitigation is not available at this time but is expected to be in the future*
Rear Axle Ratio	**5:57 or 6:83** *Diesel buses typically run a 6:17 or 6:50 gear ratio*
Comfort	**Standard Electric Convection Heating** *Optional fuel-fired heater not currently available in NYS*
Comfort	**Optional Air Conditioning** *Not available if the bus has a fuel-fired heater*

Charging	**Charging ports in either the front or rear**
Safety	**Sound Generator** *Below 20MPH to indicate bus movement.*
Front Axle	**Meritor: 10,000 lbs.**
Power	**Direct Drive Dana Motor**
Braking	**Air Disc Brakes Only**

The standard electric CE bus is equipped with all the comforts and conveniences you are used to seeing.

The Bus – Up to 2025MY

VEHICLE SYSTEMS



The Bus

INSTRUMENTATION

BEAST Spec Sheet

LEONARD Bus Sales Inc

- Type D – Transit style offers the best visibility
- 240” (20’) Wheelbase – the same as a 66 passenger
- Max Capacity of 84 Passengers
- 42,990 lb. GVWR
- 120” Wide Body – Industry standard is 96”
- Full steel, monocoque style frame. This bus does not use traditional frame rails
- AC/DC Charging Capability
- Full pass-through under storage, great for sports trips
- 140 Mile Range*

Range is approximate and will vary based on the driver, terrain, temperature, and a variety of other factors.

NanoBEAST Spec Sheet

LEONARD Bus Sales Inc

- Type A
- 170” (14’) Wheelbase
- Max Capacity of 24 Passengers
- 14,330 lb. GVWR
- 92” Wide Body
- Steel/aluminum composite frame
- AC/DC Charging Capability
- Wheelchair Lift Capable
- Direct Drive – No Transmission
- 150 Mile Range*

Range is approximate and will vary based on the driver, terrain, temperature, and a variety of other factors.

The Bus

HIGH VOLTAGE COMPONENTS

- The IC eCE incorporates multiple levels of safety in order to protect the operator and service personnel
- During operation, the system is monitoring all systems for proper operation
  - If a fault is detected, the system can reduce output to protect the occupants while keeping the bus moving
- The high voltage system operates in an isolated system throughout the bus
  - If a ground fault occurs, the system can notify the driver, while component grounding to the frame works to reduce arc risk
- Multiple levels of high voltage disconnect
  - Two disconnect switches on the side of the bus work to disable the power in high voltage components
- Master Safety Disconnect (MSD)
  - Provides a physical level of disconnect of the high voltage circuit
  - Physical release that open the electrical circuit. With these removed, the power is unable to pass

IC eCE

BUS WARRANTY

- Drive Charger, Charging Cables, and Inverters
  - 5 Years/100,000 Miles
- HV Steering Pump, Air Compressor
  - 1 Year/Unlimited
- Standard IC Chassis Warranty
- Drive Battery
  - 8 Years/175,000 Miles
- Drive Motor
  - 5 Years/100,000 Miles

Training

- As always, Leonard Bus Sales will provide its partners with all the training and support they need to feel comfortable with a new product.
- Training support and education will be offered at every level of your operation:
  - Transportation Supervisors/Directors
  - Transportation Clerks/Head Bus Drivers
  - Bus Drivers
  - Bus Attendants
  - Technicians
  - First Responders

Summary

- Designate an EV Implementation Team
  - Superintendent, Business Office, Buildings & Grounds, Transportation Department, Bus Distributor
- Watch the 3-Part Webinar series
- Be aware of “pop-up” companies making offers that sound too simple
- Begin researching architectural firms for EV understanding and capabilities
  - Interview your architects – very few are experienced in this area
- Contact your utility provider to determine facility capabilities
- Understand what funding options are available
  - How do we present this to voters?
- Look long term – do not hyperfocus on the immediate future


LEONARD
Bus Sales Inc
SCHOOL BUS
Electric Powered
Thank you