2021 Electric Truck & Bus Update, Part 2: Buses

By John Benson

September 2021

1. Introduction

This is Part 2 and focuses on buses. Battery-electric buses are being deployed more rapidly that medium and heavy battery-electric trucks, mainly because of federal and state incentives.

A major consideration, especially for electric utility professionals, is that battery-electric buses take a huge amount of energy to charge them. Also many of these vehicles will perform depot recharging en masse. This will be mostly overnight in transit depots. These facilities are currently not prepared for the massive load increase as their vehicles transition to electric operation.

The flowing is a description of and link to part 1 of this series:

https://energycentral.com/c/ec/2021-electric-truck-bus-update-part-1-trucks

The following was the last paper on this subject, which was posted in January.

Electric Refuse Trucks & Battery-Electric Buses: This post is a review of both of these two-vehicle types and considerations as they electrify.

https://energycentral.com/c/cp/electric-refuse-trucks-battery-electric-buses

Section 2 of this report will describe all major manufacturers of buses, their offerings and any new developments by those firms. Section 3 will describe how fleet managers can evaluate and remedy the overload risk described above.

2. Buses

A few of the big players in the large-to-medium truck market are also players in the bus market – see the first two below, for instance (see part 1 of this series for truck models for these two manufacturers).

Also the third firm below is not only the largest player in the bus market, and a technology leader, but is starting to spin their technologies off into other markets, including trucks

2.1. BYD

BYD was named to the 2021 Time100 Most Influential Companies:

The auto market in China is the world's largest, and the race is on to make inroads with electric vehicles. While Tesla is the market leader globally, Chinese BYD—backed by Warren Buffett—is revving up. Although the company's sales of battery-powered electric passenger cars fell 11% in 2020, demand for its electric luxury sedan, launched in July, is steadily rising. BYD also manufactures electric buses in the U.S. and Europe and has entered into a partnership to help build Japan's first pure electric bus-loop line. Among its other businesses: rail systems, batteries—for consumer goods as well as renewable-

energy storage-—and components for handheld electronics. The company's Hong Kong–listed shares are up more than 300% over the past 12 months.[1]

The following are the busses that BYD offers:

2.1.1. School Buses

BYD ("Build Your Dreams"), the world leader in electric vehicles, is introducing a battery-electric ***Type D school bus*** *with unparalleled safety features and performance, wrapped in a sleek design that will have students wanting to step onboard.*[2]

With length options of 35, 38, and 40 feet, BYD's Type D battery-electric school bus is perfect for transporting students to classes, field trips, as well as athletic and band events. The Type D can seat up to 84, and can be equipped with an ADA lift-gate. The bus has a range of up to 155 miles on a single charge.

2.1.2. Transit, Motor Coach and Double Decker

BYD makes transit buses in 30 foot to 60 foot lengths, which can accommodate from about 20 to about 50 passengers.[3]

BYD makes motor coaches from 23 foot to 45 foot lengths, which can accommodate from 16 to 57 passengers.

BYD makes two double decker buses: 35 and 45 foot. The former seats around 50 passengers, and the latter: around 75.

Ranges of the above are roughly from 125 to 170 miles

Note that they also seem to be offering articulated buses per the first news release in the next subsection.

2.1.3. Other News

BYD (Build Your Dreams) announced that ***Antelope Valley Transit Authority****, a longstanding customer and community partner, is growing its battery-electric fleet with the purchase of 10 K11M 60-foot articulated buses and six K7M 30-foot buses.*[4]

AVTA, which serves northern Los Angeles County and portions of southern Kern County, was the first transit agency in North America to make the decision to go 100% battery-electric. Since then, AVTA has put 57 BYD zero-emission buses into revenue service.

BYD, (Build Your Dreams), the Official Sponsor of Mother Nature, Thursday announced it has delivered its 500th American-made electric bus in time for Earth Day 2021.[5]

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[1] Time, "2021 Time100 Most Influential Companies", https://time.com/collection/time100-companies/5949997/byd/
[2] BYD, "BYD to Revolutionize Electric School Buses," https://en.byd.com/news-posts/byd-to-revolutionize-electric-school-buses/
[3] BYD, Buses, https://en.byd.com/bus/
[4] BYD, "AVTA Adds ABQ Buses to Its Growing Fleet of BYD Battery-Electric Buses," May 6, 2021, https://en.byd.com/news-posts/avta-adds-abq-buses-to-its-growing-fleet-of-byd-battery-electric-buses/
[5] BYD, "BYD Celebrates Earth Day with Delivery of 500th American-Built Bus," April 22, 2021, https://en.byd.com/news-posts/byd-celebrates-earth-day-with-delivery-of-500th-american-built-bus/

*The 500th bus is a 30-foot K7M, one of 130 such buses being built for the **Los Angeles Department of Transportation** in what is the largest single order of battery-electric buses to date in the United States. The electric bus order is part of the City of Los Angeles' "Green New Deal," a set of sustainability goals that includes converting the entire LADOT fleet to zero-emission buses by 2030.*

***Washington state** officials chose California-based BYD (Build Your Dreams) to participate in a statewide purchase agreement that gives transit agencies throughout The Evergreen State and the United States the ability to buy American-made BYD coaches and buses.[6]*

The vehicles, which comply with strict Buy America standards, are manufactured by union workers with the Sheet Metal, Air, Rail and Transit Workers, Local 105, headquartered in Southern California.

*BYD are already in service with **Wenatchee's LINK Transit.***

BYD announced Tuesday the inaugural members of the "Million Mile Club" — U.S. transit services that have logged over 1 million service miles with their fleets of zero-emission BYD battery electric buses.[7]

***Antelope Valley Transit Authority** (3.4 million zero-emission miles), which serves northern Los Angeles County...*

***Stanford University** (2.5 million zero-emission miles), began using BYD buses in 2014 on its free Marguerite Shuttle ...*

***Denver RTD** (1.3 million zero-emission miles), bought BYD buses in 2016 for the city's free 16th Street Mall service...*

2.2. Daimler / Thomas Built "Jouley" Buses

Thomas Built Buses (TBB), a leading manufacturer of school buses in North America, its exclusive Virginia dealer, Sonny Merryman Inc., and Proterra Inc ("Proterra"), a leading innovator in commercial vehicle electrification technology, celebrated the delivery of the 50th Saf-T-Liner C2 Jouley battery-electric school bus. The milestone delivery went to Loudoun County Public Schools in Virginia as part of phase one of Dominion Energy's Electric School Bus Initiative…[8]

In 2018, TBB and Proterra unveiled the high-performance Jouley electric school bus. Now, these 50 nationwide deployments represent the first Thomas Built, Proterra Powered battery-electric school buses to hit the roads as cities, towns, and school districts transition to all-electric school bus fleets.

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[6] BYD, "Washington State Selects BYD for Statewide Contract," April 6, 2021, https://en.byd.com/news-posts/washington-state-selects-byd-for-statewide-contract/

[7] BYD, "BYD Honors The First U.S. Transit Members of the '1 Million Zero-Emission Mile Club'," Dec 29, 2020, https://en.byd.com/news-posts/byd-honors-four-u-s-transit-customers-as-members-of-the-first-1-million-zero-emission-mile-club/

[8] Daimler, "Thomas Built Buses Delivers 50th Proterra Powered Electric School Bus," May 5, 2021, https://daimler-trucksnorthamerica.com/PressDetail/thomas-built-buses-delivers-50th-proterra-2021-05-05

2.3. Proterra

To date, Proterra has helped more than 100 public transit customers throughout the continent implement battery-electric buses and charging infrastructure, powering the shift to 100% electric fleets.[9]

The above paragraph is a major reason for Proterra's success in the past. However, in the future they plan to diversify, in a big way. First of all, on June 15 of this year, Proterra became a public company:

- *Proterra begins trading on the Nasdaq Global Select Market today after completing business combination with ArcLight Clean Transition Corp.*[10]
- *More than $640 million raised to fund growth initiatives, including next-generation battery program*
- *With more than 600 vehicles on the road and its industry-leading battery systems proven over 20 million service miles driven, Proterra positioned to accelerate electrification of commercial vehicle market as a public company*

Proterra already offers a wide range of buses for transit fleets, but they are now expanding this to offer their technology for other major electric vehicle manufacturers (see the prior subsection), including those that make:

- School buses
- Motor coaches
- Shuttle buses
- Delivery trucks, including the MT50E Electric Delivery Truck from Freightliner
- Off-shore bus manufacturers
- Off-road construction equipment, including an electric excavator from Komatsu
- Off shore large delivery trucks
- Class 3 commercial vans

Proterra is also offering full charging infrastructure development, including any energy management functions.

2.4. Gillig

Gillig (formerly Gillig Brothers) is an American designer and manufacturer of buses. The company headquarters, along with its manufacturing operations, is located in Livermore, California. By volume, Gillig is the second-largest transit bus manufacturer in North America (behind New Flyer). As of 2013, Gillig had an approximate 31 percent market

[9] Proterra, Public Transit, https://www.proterra.com/applications/public-transit/
[10] Proterra, "Proterra, a Leading Innovator in Commercial Vehicle Electrification Technology, to Debut on Nasdaq Today," June 15, 2021, https://www.proterra.com/press-release/proterra-becomes-public-company/

share of the combined United States and Canadian heavy-duty transit bus manufacturing industry, based on the number of equivalent unit deliveries.[11]

GILLIG's Battery Electric bus integrates the Cummins electrified powertrain with the proven Low Floor platform to bring the most comprehensive, advanced zero-emission bus to the market. With over 200 years of combined transit experience and a nationwide service network, GILLIG is leading America's zero emissions future with its Cummins-powered Battery Electric buses.[12]

Pullman Transit received two electric buses on June 30, helping to cut costs and be more sustainable.[13]

Extensive research was done regarding the vehicles' cost, projected maintenance and the efficiency of electric versus diesel buses, said Pullman Transit Manager Wayne Thompson. Using information from Wenatchee Link Transit, Wayne estimates each electric bus will cost around $4,000 a year to charge.

The yearly cost to fuel a diesel bus is around $20,000, Thompson said. The electric buses can travel more than 150 miles on a full charge, he said. The longest route in Pullman is the Loop Route, which travels around 147 miles each day.

Pullman City Council allowed Pullman Transit to move forward with purchasing the electric buses in 2018, Thompson said. The federal Buses and Bus Facilities grant program covered 80 percent of each of the $872,000 electric buses. Both buses were purchased 16 months ago, replacing two diesel buses from the 1990s.

In the St. Louis region that includes parts of both Missouri and Illinois, representatives from Bi-State Development, Metro Transit and several partners and regional stakeholders launched the first electric buses into service on the MetroBus system. Metro has purchased four 40-foot battery-electric buses made by GILLIG, with six more to follow later this year.[14]

The Utah Transit Authority (UTA) and Park City Transit have awarded GILLIG a $44.2 million contract for 44 battery electric buses, with an option of 95 additional buses over five years. The contract includes 16 plug-in charging systems and four high-power on-route chargers…[15]

UTA has designated 11 of the initial buses to operate on the 5.3-mile Ogden Bus Rapid Transit line which will run from Ogden FrontRunner Station, through downtown Ogden, through the Weber State University campus to McKay-Dee Hospital. Of the 44 electric buses in the initial contract, thirteen will be delivered to Park City, Utah.

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[11] Wikipedia Article on "Gillig," https://en.wikipedia.org/wiki/Gillig
[12] Gillig, "Zero-Emission Battery Electric," https://www.gillig.com/battery-electric
[13] Gilligm "Pullman Transit to become more sustainable," July 16, 2021, https://www.gillig.com/post/pullman-transit-to-become-more-sustainable
[14] Gillig, "GILLIG makes two electric bus deliveries in three US states," July 12, 2021, https://www.gillig.com/post/gillig-makes-two-electric-bus-deliveries-in-three-us-states
[15] Gillig, "GILLIG scores a 44 e-bus contract in Utah (and up to 139)," May 24, 2021, https://www.gillig.com/post/gillig-scores-a-44-e-bus-contract-in-utah-and-up-to-139

2.5. New Flyer (NFI Group)

The Buses product name is “New Flyer,” the Company name is NFI Group. Each has its own web site (links below).

https://www.newflyer.com

https://www.nfigroup.com/press-releases/

Except the NFI Group also owns a UK Bus Manufacturer (Alexander Dennis Limited) that seems to have ties to BYD.

The New Flyer buses seem to be hanging their hat on a wide range of fuels and power plants. These include:

- Xcelsior CHARGE NG™, battery electric bus
- Xcelsior CHARGE H2™, hydrogen / fuel cell electric bus with 350 mile range
- Xcelsior® CNG, Compressed natural gas + IC engine
- Xcelsior® Trolley, Kiepe Electric Trolley Drive System (direct electric drive)
- Xcelsior® Hybrid, diesel-electric hybrid
- Xcelsior® Clean Diesel, not so clean diesel

I believe the strategy of offering as many variants is not going work well, even though New Flyer is the current overall market leader. The conversion to battery electric buses is being heavily subsidized by the Federal and many state governments (like California). This is probably going to suck the life out of any other technology.

Also the State of California released a “Comparison of Medium- and Heavy-Duty Technologies in California” that completely rejected any technology other than battery electric as being able to meet their GHG reduction goals. I have mostly completed a post on this and will release it a few days after this one.

2.6. Green Power Motor Company

This company has headquarters in Vancouver, BC, Canada, with sales offices and manufacturing facilities in California.[16]

They offer a reasonable line of buses, including several light and medium buses based on the same medium van-like platform (see the EV Star below). They also make box truck, cab-and-chassis-only, and cargo van configurations from this same platform.

Then Green Power makes a school bus, a 30 ft. and 40 ft. conventional bus and a double decker bus. All buses described in the table below.

Product name	Passengers	GVWR or Length	Range (miles)
EV Star	20	14,330 lbs.	Up to 150
EV Star Plus	24	14,330 lbs.	Up to 150
BEAST (battery electric automotive school transportation)	90	40 ft.	Up to 150
EV-250	23	30 ft.	Up to 140
EV-350	42	40 ft.	Up to 200
EV-550 (double-decker)	99	45 ft.	>175 miles

[16] Green Power Motor Company, https://greenpowermotor.com/

2.6.1. Clients

Over the last decade, GreenPower Motor Company has seen remarkable growth within the electric vehicle industry. Our expansion of vehicles has ranged from transit to cargo as well as school buses. Some notable accomplishments within the company include scoring one of the highest scores ever recorded (92.2) from the Altoona Bus Testing and completing compliance with Buy America, ADA, and FMVSS regulation. GreenPower also successfully completed an uplist to the Nasdaq stock exchange and grew its customer network throughout North America. We've worked with major clients such as:

- Sacramento Regional Transit
- Creative Bus Sales
- Forest River
- Jacksonville Transportation Authority
- Green Commuter
- San Diego Airport Parking Company
- City of Vancouver
- Antelope Valley Transit Authority
- Airline Coach Services
- UCLA
- UCSF

2.6.2. 2020 Earnings & Deliveries

For the year ended March 31, 2020, GreenPower generated record revenue of $13.5 million compared to $6.1 million for the previous year, an increase of 122%. Gross profit

for the year was 30% of revenue, which is the company's target incorporating a blend of all of GreenPower's products.[17]

GreenPower enjoyed record deliveries of 68 vehicles for the year, including 62 EV Stars, four Synapse school buses and two EV350 40-foot low floor transit buses. These were across a wide range of sectors, including shuttle, micro-transit services, vanpooling schools and transit properties. In March of this year, GreenPower's operations were temporarily curtailed in response to the COVID-19 pandemic and government's stay in place orders…

2.6.3. Autonomous Vehicle?

GreenPower's EV Star expected to enter full Level 5 Autonomous Service with JTA in early 2021; GreenPower, Perrone and First Transit have signed an agreement to build second fully autonomous EV Star for demonstration tour in early 2021. [18]

GreenPower Motor Company Inc. (NASDAQ: GP) (TSXV: GPV) ("GreenPower"), a leading manufacturer and distributor of zero emissions electric powered medium and heavy duty vehicles, today announced that it has delivered the first fully autonomous EV Star to Jacksonville Transportation Authority (JTA) in collaboration with Perrone Robotics.

The JTA is currently working with local colleges, medical campuses, and other partners to create the nation's first public transportation network powered by autonomous vehicles. GreenPower's fully autonomous EV Star, developed in collaboration with Perrone Robotics, is expected to enter service in February 2021 after an initial calibration period…

Note from author: I did find a confirming press release from JTA (linked below), and it had a bit more information. I would guess this is real, but probably on a fixed route with limited challenges. It would still be impressive if is successful. I did not see any more articles on this subject after these two "delivery" releases in December 2020.

https://u2c.jtafla.com/media-center/news-press/jta-takes-delivery-of-fully-autonomous-greenpower-ev-star/

3. Buses Charging Infrastructure

As I pointed out in the Introduction, it is highly likely that bus depots will have a big problem with electric capacity as they increase the percentage of battery-electric buses in their fleet. My associates at Microgrid Labs, have been helping the fleet managers understand this problem, and potential solutions to it. The following are case studies from their site followed by a brief description of their software.[19]

[17] AlphaStreet, "Greenpower Motor Company Inc. (GPV) Q4 2020 Earnings Call Transcript," July 27, 2020, https://news.alphastreet.com/greenpower-motor-company-inc-gpv-q4-2020-earnings-call-transcript/
[18] Green Power Motor Company, "Greenpower and Perrone Robotics Deliver Nation's First Fully Autonomous EV Star to Jacksonville Transportation Authority," Dec 18, 2020, https://greenpowermotor.com/greenpower-perrone-robotics-deliver-ev-star-jacksonville/
[19] Microgrid Labs, Inc., https://microgridlabs.com/

3.1. Case Studies

*The **Massachusetts Bay Transportation Authority**, more commonly known as the T, is one of the oldest public transit systems in the United States. It's also the largest transit system in Massachusetts. As a division of the Massachusetts Department of Transportation (MassDOT), the MBTA provides subway, bus, Commuter Rail, ferry, and paratransit service to eastern Massachusetts and parts of Rhode Island.*

As MBTA and Mass CEC make a commitment to reducing GHG emission and convert their fleet to an all-electric fleet, the project requires route analysis, bus battery sizing, building charging infrastructure and upgrades to electrical infrastructure.

Enel X and Microgrid Labs are supporting the transition to Electric Vehicles by providing an innovative electrification planning and analysis solution that will help develop MBTA's electrification strategy.

The analysis will include insights regarding the optimal sizing of vehicle powertrain, battery, charging infrastructure, energy infrastructure including microgrids, as well as the development of an optimal charging strategy.

Via Mobility, City of Boulder, CO

Feasibility Study and Charging Infrastructure Sizing: Via Mobility is a non-profit transit agency that focuses on providing public transportation services in the State of Colorado operating a fleet of ~180 vehicles that includes a mix of light-, medium-, and heavy-duty vehicles.

As Via Mobility and City of Boulder make a commitment to reducing GHG emission and convert their fleet to an all-electric fleet, the fleet requires route analysis, bus battery sizing, building charging infrastructure and upgrades to electrical infrastructure.

Microgrid Labs is supporting the transition and adoption of Electric Vehicles by conducting preliminary analysis including modeling the charging process, quantifying the electrical demands, assessing the impact on electrical network and optimizing the size of the charging infrastructure.

The modeling also includes recommendations for installing Solar PV, battery energy storage systems, and other sources of on-site generation in order to reduce the operating cost, increase renewable based generation and build resiliency for the bus service and for the city.

Ameren and EPRI, Saint Louis, Missouri

Microgrid Labs is supporting Ameren & Electric Power Research Institute (EPRI) in developing an electrification plan for the Hazelwood School District in the St. Louis Metro area. Hazelwood is electrifying their fleet of 100 school buses in order to provide more sustainable and healthier transportation for students and the community.

EVOPT (see below) will be utilized to determine potential charging strategies and load profiles for the electric school bus fleet to be deployed in the School District. The electrification plan will include a complete feasibility study, a zero-emission fleet transition plan, and modeling depot operations to confirm the plan's viability.

Enel X, South San Francisco, California

Microgrid Labs is supporting ENEL X during the planning and development of a new bus depot in South San Francisco, CA. This depot will be capable of housing a fully electric fleet of 60 buses and charging infrastructure. As part of the private bus fleets broader plans to design facilities to serve a zero-emissions e-bus fleet, MGL and Enel X will provide an innovative electrification planning and analysis solution that will help develop the bus electrification strategy.

As the private fleet makes commitments to reducing GHG emissions and convert their fleet to all-electric operation, their project will require route analysis, bus battery sizing, parking lot charging infrastructure upgrades and upgrades to electrical infrastructure.

3.2. Modeling and Optimization Software (EVOPT)

EVOPT is software for modeling, simulation and optimization of Electric Vehicle Battery, Charging and Energy infrastructure. This application is used both by Microgrid Labs consultants and clients to:

- Jointly model the driving /charging process: EVOPT quantifies electrical demand and derives the right balance of vehicle battery, charging infrastructure, and operational needs.
- Planning fleet electrification especially for medium and heavy vehicles

EVOPT was jointly developed with the University of California, Berkeley under a National Science Foundation (NSF) award. Go through the link below for more information.

https://microgridlabs.com/evopt-1