

The U.S. Electric Bus Transition: An Analysis of Funding and Financing Mechanisms

by

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Executive Summary

Electric buses are poised to represent an increasingly larger share of the United States bus market due to the benefits of avoided air pollution, zero carbon emissions, and lower operation & maintenance costs. However, while total cost of ownership is approaching parity for electric buses versus diesel buses (and in some cases, even undercutting diesel), transit agencies and municipalities face the common problem of higher upfront capital expenditures required for electric buses versus traditional diesel-powered alternatives. This study examines the current mechanisms by which public transit agencies have procured electric buses to date as well as new, innovative financing models, with a focus on four states that have been highly active in this space: California, South Carolina, Texas, and Washington.

23 interviews were conducted: thirteen with transit agencies, five with electric bus manufacturers, and two with state and federal agencies. In addition, interviews were conducted with one electric utility and one investment fund respectively as well as two non-profit consulting firms that focused specifically on transportation. All of this research was augmented by secondary literature reviews and thorough data collection from sources such as the Federal Transit Administration, the California Air Resources Board, and CalStart. Transit agency investment, fiscal, budget, and transit planning documents were also reviewed and analyzed.

The electric bus ecosystem revolves primarily around three types of organizations. First, as the main customers for electric buses, transit agencies serve local metropolitan areas and must plan on retiring buses at the end of their lifetimes, amongst other infrastructure investments. Next, there are four domestic electric bus manufacturers – Proterra, BYD, New Flyer, and GreenPower Bus – that are the dominant forces in the industry, although more manufacturers have and will enter the market. Finally, federal and state agencies provide the bulk of grant funding that finances the current transition to electric buses. In addition to these three types of organizations, there are also other supporting organizations, such as utilities, financiers, and consultants.

Current funding sources rely heavily on federal sources from the Federal Transit Administration, whose most notable program for electric buses is the Low-or-No Emissions Grant program offering between \$55 and \$85 million per year. Other key federal programs that are not specific to electric buses are the Bus and Bus Facilities Grant Program (\$366 million in 2018), the Capital Investments Grants program (\$2.3 billion annually), and the Federal Highway Administration’s Congestion Mitigation and Air Quality program (\$2.3-\$2.5 billion annually). At the state-level, California provides a large pot of funding via revenue generated from its cap-and-trade program, which is then distributed through a number of zero-emissions bus programs. Electric bus-specific grants from other states are minimal. Volkswagen emissions settlement funds comprise the remainder of available grant funds.

New financing models have evolved over the past few years, although with limited adoption to date. First, leasing arrangements have gained the most commercial momentum, where electric buses can be holistically or partially leased – the latter usually in the form of a battery lease. These lease models reduce the upfront capital expenditures needed to purchase an electric bus. Two case studies are provided on electric bus and battery leasing: Proterra’s battery lease arrangement with Park City Transit (Utah) and BYD’s partnership with Generate Capital to offer bus financing, primarily via leases.

Second, utility investment into electric charging infrastructure is examined as a potential business model, which can shift the burden of electrical system design, distribution system upgrades, and charging load management to companies that specialize in delivering electricity. Portland General Electric’s partnership with TriMet, a Portland, Oregon-based transit agency, is examined as a case study. In this case, Portland General Electric obtained approval from the Oregon Public Utilities Commission to include electric bus

charging infrastructure (along with unrelated light-duty charging infrastructure) in its rate base, where it will earn a regulated rate of return.

The third business-model studied was energy- or transportation-as-a-service, where multiple companies have begun making ventures into revenue models such as dollars per mile or dollars per kilowatt-hour charged that align with the bus lifetimes. Three models from Amply Power, Generate Capital, and Clean Energy Works are studied in this section. These models are another way to shift the administrative burden of dealing with charging and electrical infrastructure away from transit agencies, whose core mission is to provide transportation services and not electricity.

This report also discusses electric bus deployments for the City of Porterville (California), the City of Greenville (South Carolina), Dallas Area Rapid Transit (Texas), Everett Transit (Washington), and Antelope Valley Transit Authority (California). These examples showcase the wide range of buses, grants, charging infrastructure, and processes that make each transit agency's transition to electric buses unique.

To achieve a large-scale transition to electric buses, the industry needs to focus on five primary goals:

1. Scale up manufacturing and navigate the challenges of Buy America requirements (65% of costs must be domestically sourced) as well as high levels of customization required from transit agencies.
2. Aggregate purchases to purchase larger volumes of electric buses by conducting joint procurements with local transit agencies or by developing state-level master procurement contracts that standardize
3. Increase deal size from a financial perspective as well, which is assisted by aggregated purchases. This may increase the dollar value of transactions to the tens of millions, which begins drawing investment capital that could help the industry scale further.
4. Improve investor and industry confidence in electric bus technologies. A better understanding of key issues like battery degradation and range performance under varying environmental conditions (which will come naturally with more years of performance data) will drive further investment and buy-in into electric buses.
5. Develop better supporting policy for electric bus adoption, particularly from a regulatory perspective to enable utilities to have the option to get involved with infrastructure.

Achieving these goals would accelerate the transition of the U.S. bus fleet from diesel and compressed natural gas buses towards a cleaner, modernized electric bus fleet.

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Please feel free to contact me at my personal email address regarding this report: dexter.cc.liu@gmail.com.

Section #1: The Electric Transit Bus Industry

Introduction & Market Trends

In the last five years, electric buses have surpassed the pilot technology stage and are being deployed as viable, commercial alternatives to traditional diesel buses. The benefits of electric buses versus diesel buses in public transit usage are well-documented across many literature sources. Electric buses eliminate point-source emissions in cities with no nitrous oxide byproducts generated at the tailpipe and also reduce carbon dioxide emissions as electricity grids grow increasingly carbon-light. This has led to global initiatives and collaborations such as the C-40 Fossil Fuel Free Streets Declaration, which has increased from an original 13 cities to 94 cities pledging to only purchase electric buses from 2025 onward. As of April 2019, the current list of U.S. cities includes Seattle, Portland, San Francisco, Los Angeles, Austin, Houston, New Orleans, Chicago, Washington D.C., Philadelphia, New York, and Boston. Some cities have taken this initiative further, such as Los Angeles shifting its entire 2,200+ bus fleet to zero emission buses and San Francisco converting to an all-electric bus fleet by 2035.^{1,2}

Figure 1: C-40 City Signatories (as of February 2019)³



Another core benefit of electric buses is the lower lifetime cost of the bus versus traditional diesel counterparts. Higher upfront capital investment in electric models are offset by fuel and maintenance savings during the expected twelve-year bus life. Cities that were early movers in the electric bus space recognized the economic benefit of bringing manufacturing benefits to their local economy in the case of Greenville (South Carolina) with Proterra, Lancaster (California) with BYD, and Porterville (California) with GreenPower Bus. Finally, other benefits such as noise pollution reduction, technology modernization (for the purposes of city perception/image), and expanded public transit access (particularly for low income areas) are frequently touted as reasons to adopt electric buses.

¹ The Los Angeles Times (2017). "Electric Buses are L.A.'s Transit Future".

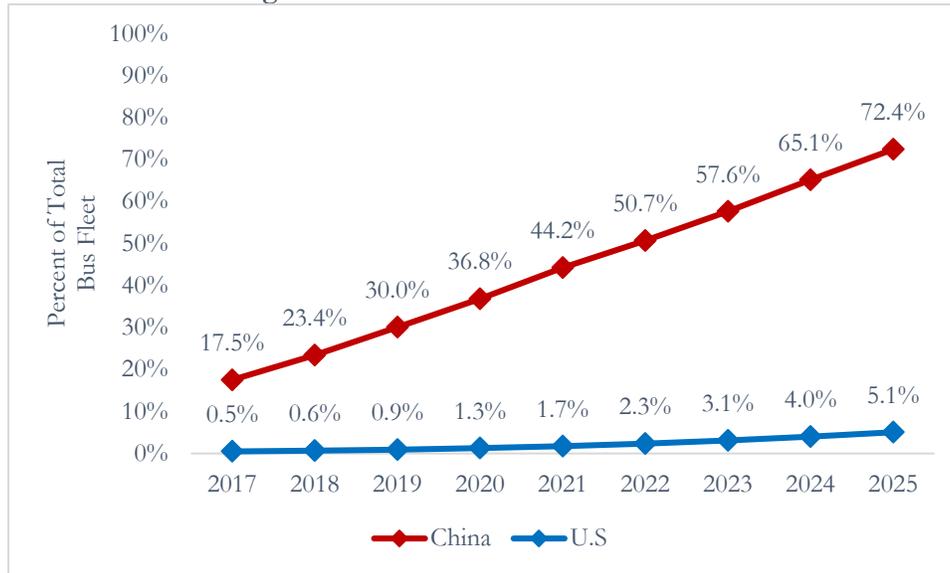
<https://www.latimes.com/opinion/editorials/la-ed-electric-buses-20170620-story.html>

² Green Car Congress (2018). "San Francisco Commits to All-Electric Bus Fleet By 2035; MUNI Board Approves Pilot Program." <https://www.greencarcongress.com/2018/05/20180516-muni.html>

³ C40 Cities (2019). Map of C-40 City Signatories. <https://www.c40.org/cities>

Bloomberg New Energy Finance (BNEF) estimates that there were 385,000 electric buses on the road by the end of 2017.⁴ However, the overwhelming majority of these buses have been deployed in China, with only 360 electric buses estimated to be in use in the United States. In addition, BNEF forecasts that electric buses will reach 72.4% penetration of China’s entire bus fleet by 2025, whereas market penetration will only incrementally increase to 5.1% in the United States (as shown in Figure 2) in that timeframe. China’s massive growth in electric bus deployment can be ascribed to two main factors.

Figure 2: Electric Bus Fleet Penetration⁵



First, highly centralized decision-making enables a coordinated effort between bus manufacturing and municipal procurement, both of which are mandated. This essentially forms a national target for the electric bus industry that is supported by subsidies and homogeneity. Second, fast-paced urban population growth necessitates new transportation infrastructure beyond what already exists, meaning that much of China’s electric bus purchases are new and in addition to existing diesel fleets. Concurrent city expansion means that building up new electrical infrastructure is less troublesome than working around existing electrical wiring, foundations, and non-electric utilities (water, gas, communications, and sewage systems). Finally, high-volume manufacturing in the thousands and tens of thousands per year (per manufacturer) has driven down upfront costs for both battery packs and overall buses.

Significant obstacles remain towards widespread electric bus deployment in the U.S., with the bus market being significantly different than in China. Decision-making is distributed to local transit agencies and municipalities (and to a lesser extent, states), who are responsible for transit investments. The independent nature of transit agency decision-making means that bus purchases are made at the transit agency and municipality level. This means that industry education is needed for each transit manager, maintenance supervisor, and route planner, which places bandwidth restrictions on the sales teams of electric bus manufacturers. As a result, purchases are often made in small, pilot-like volumes as opposed to hundreds at a time. Further restricting deployment is the fact that the United States has only a loose national policy around transitioning its bus fleet towards zero-emission vehicles, with the only dedicated subsidy program for electric

⁴ Bloomberg New Energy Finance (2018). “Electric Buses in Cities”. <https://about.bnef.com/blog/electric-buses-cities-driving-towards-cleaner-air-lower-co2/>

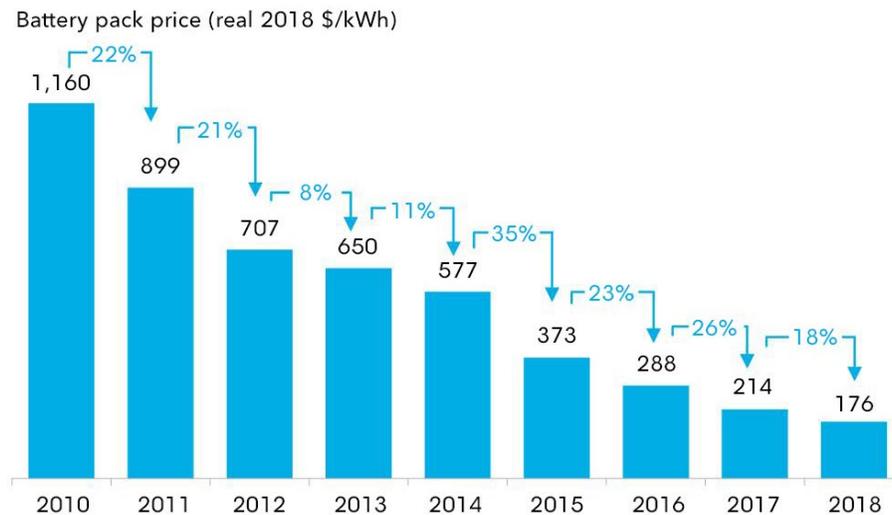
⁵ Bloomberg New Energy Finance (2018). “The Global Electric Bus Market Gets Into Gear (Part 2)”.

transit buses being the Federal Transit Administration’s Low or No Emissions Grant Program (with a relatively light \$85 million annual budget).

Lithium-ion battery costs have been rapidly dropping thanks to the proliferation of light-duty electric vehicles, consumer electronics, and to a lesser extent, grid battery applications. Battery pack prices have fallen 85% from \$1,160/kWh in 2010 to \$176/kWh in 2018, as seen in Figure 3 from Bloomberg New Energy Finance below. Given that battery packs are a significant fraction of the costs of an electric bus, overall bus prices are decreasing as a result.

, electric buses are also falling in cost

Figure 3: Bloomberg New Energy Finance’s Lithium-Ion Price Survey Results⁶



In addition, current levels of grant funding from federal, state (primarily California), and Volkswagen emission settlement sources have been sufficient for current levels of electric bus deployment, as discussed further in Section #3. CalStart, a California-based non-profit consulting firm that focuses on helping accelerate clean transportation technologies, released a survey-based report in August 2018 that showed that 1,583 electric buses in total were deployed or ordered across 139 transit agencies.⁷ As expected, California dominates in electric bus deployments and orders, but some surprising states like Florida, Indiana, Pennsylvania, and Kentucky also push into the top ten.

⁶ Bloomberg New Energy Finance (2019). “A Behind the Scenes Take on Lithium-ion Battery Prices”. <https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/>

⁷ CalStart (2018). “A Survey of Zero Emission Buses Across North America.” <https://calstart.org/wp-content/uploads/2018/11/Breathing-Easy-August-2018.pdf>

Figure 4: Electric Bus Deployments or Orders by State

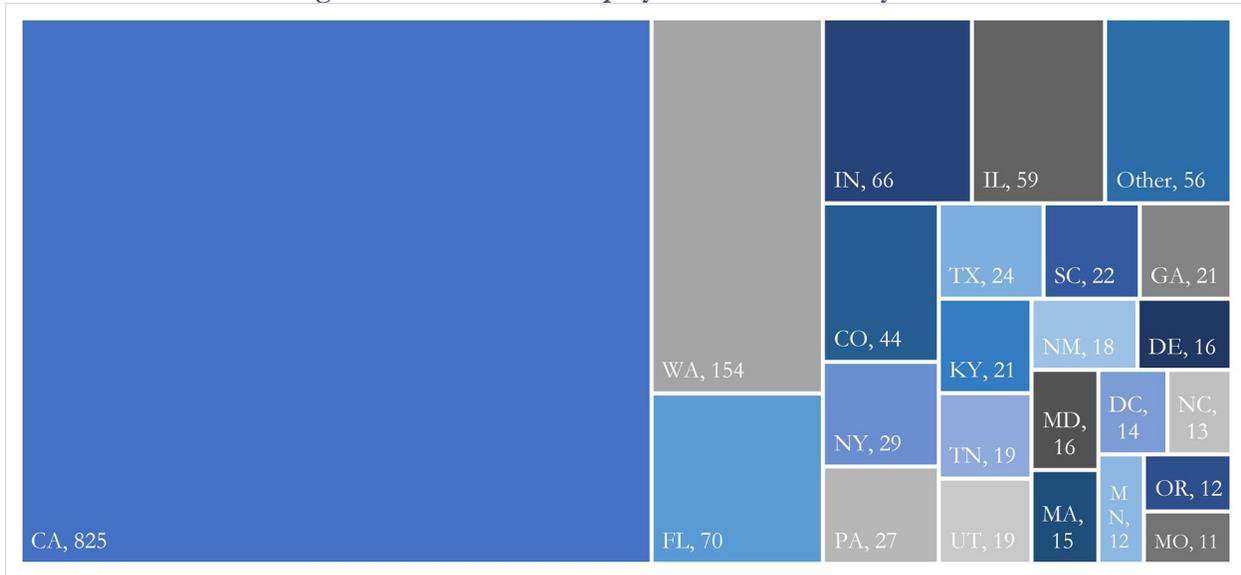
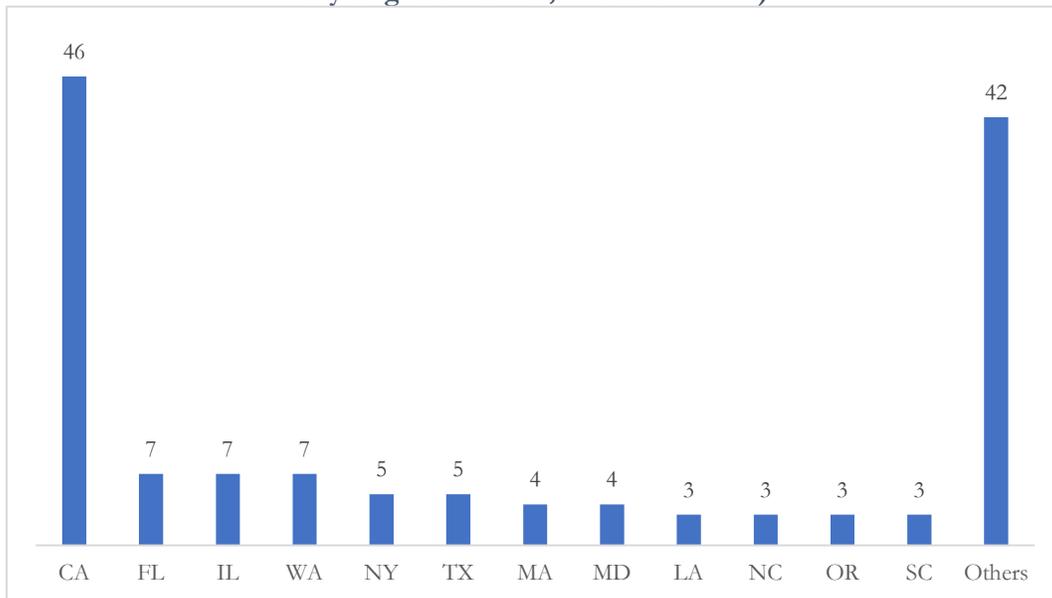


Figure 5: Active Transit Agencies in the Zero Emissions Space by State (Battery Electric or Hydrogen Fuel Cell; 3 or more buses)



Research Purpose & Methodology

In the absence of mandated procurement targets, a government-supported manufacturing industry, and heavy subsidies, electric bus deployment has much room for growth in the United States but faces the aforementioned challenges. The primary concern for most transit agencies is the high upfront capital cost of electric buses, which is estimated at \$580,000 USD in 2017 for a 350 kWh electric bus by Bloomberg New Energy Finance and at around \$700,000 by the U.S. PIRG Education Fund, the latter with an estimated \$200,000 premium over diesel buses.^{8,9} Note that this cost varies significantly in actual data collected from

⁸ Ibid.

⁹ U.S. PIRG Education Fund (2018). “Paying for Electric Buses”.

<https://uspig.org/sites/pirg/files/reports/National%20-%20Paying%20for%20Electric%20Buses.pdf>

transit agency interviews and review of transit agency financial documentation, with price tags ranging between \$850,000 to \$900,000 per vehicle prior to charging infrastructure, installation, and design costs.

Despite this higher upfront cost, electric buses demonstrate lifetime cost advantages over diesel buses via maintenance and operational savings. This paper focuses on the tradeoff between the upfront cost premium and lifetime operational savings by exploring the following topics:

1. What the current ecosystem looks like for the electric bus industry, including major manufacturers, technologies, transit agencies, state governments, and federal agencies;
2. What current funding sources and business models look like;
3. Examples of how transit agencies approach the decision to transition to an electric bus, their infrastructure needs, and how they approach financing these transitions, and;
4. Key takeaways and recommendations for the electric bus industry as it scales up in commitment and volume.

This paper's research was informed by 23 separate interviews conducted with electric bus manufacturers, consulting firms, government agencies, utilities, financing companies, and most importantly, transit agencies. The 13 transit agencies interviewed spanned four separate states: California, Washington, South Carolina, and Texas. These primary sources of information were supplemented by secondary research into sources such as the National Transit Database, public government funding reports, transit agency annual reports, and industry articles.

Section #2: Current Ecosystem & Procurement Process

This section covers the current ecosystem of electric buses and how transit agencies have historically made the decision to focus on electric buses along with what the procurement process looks like.

Electric Bus Manufacturers

This report focuses on large capacity transit buses that are typically between 35 to 45 feet long (with 40 foot being the “standard” for transit agencies) and seat between 32-44 passengers. There is a high level of customization resulting significant variance between bus specifications. Electric bus rated efficiencies range from 1.4 to 2.4 kWh/mile (depending on bus specifications, route elevation, start/stop frequency, and many other factors), which translates to between 14 and 24 miles per gallon equivalent. This compares to three to five miles per gallon for traditional diesel transit buses.¹⁰ Given that battery packs range from 94 kWh to 660 kWh, this results in maximum rated distances between 37 to 390 miles, based on various manufacturer specifications. Table 1 below shows a list of each of the major electric bus manufacturers active in the United States market, with Proterra and BYD leading the way with the most deployments to date.

Table 1: Active Electric Transit Bus Manufacturers in the U.S. & Flagship Model Specifications

Company	Flagship Models	Battery Size & Distance	Notes
Proterra¹¹	Catalyst E2	94-660 kWh, 68-426 miles	Well-known manufacturer of electric buses with large USA market share, founded in 2004 and headquartered in Burlingame, California
BYD USA¹²	BYD K9	~500 kWh, ~255 miles	USA-based subsidiary of Chinese company BYD with strong traction in market, having setup its Lancaster-based facility in 2013
New Flyer¹³	Xcelsior CHARGE	100-545 kWh, up to 260 miles	Historically a Canadian-based diesel bus manufacturer that began developing an electric bus product line in 2011
GreenPower Bus¹⁴	EV300-400 Series	260-320 kWh, 175-185 miles	Founded in 2014 with its headquarters in Vancouver, Canada and a manufacturing facility in Porterville, CA; focuses on transit buses, shuttles, and mini-buses.

This table does not include companies such as NovaBus, Complete Coach Works, eBus, Gillig, or El Dorado International, who are active in the USA but either have low current electric bus sales volumes or work on diesel bus refurbishments with electric drivetrains. In addition, there are a multitude of companies active in other countries. The latter includes Yutong, Zhongtong, Nanjing Jinlong, Zhuhai Yinlong, and Futian Ouhui, which are five extremely large electric bus manufacturers active in the Chinese market (alongside BYD) with larger annual sales volume than any North America manufacturer. In addition, Solaris (Poland), Optare (United Kingdom), VDL (Netherlands), and Volvo (Sweden) are active in the European market, although

¹⁰ Alternative Fuels Data Center (2018). “Average Annual Fuel Use of Major Vehicle Categories”. <https://afdc.energy.gov/data/10308>

¹¹ Proterra (2016). Catalyst: 40-Foot Bus Specifications. <https://www.proterra.com/wp-content/uploads/2016/08/Proterra-Catalyst-Vehicle-Specs.pdf>

¹² BYD (2018). K9 Electric Transit Bus Brochure. <https://en.byd.com/wp-content/uploads/2018/04/k9mc.pdf>

¹³ New Flyer (2018). Xcelsior CHARGE Brochure. https://www.newflyer.com/site-content/uploads/2018/10/Xcelsior-CHARGE_2-19_NE.pdf

¹⁴ GreenPower Bus (2019). “Product Line: All-Electric Transit & School Buses”. <https://www.greenpowerbus.com/product-line/>

with significantly smaller production numbers than the Chinese manufacturers. This landscape could change at any time if any of these manufacturers decide to enter the U.S. market.

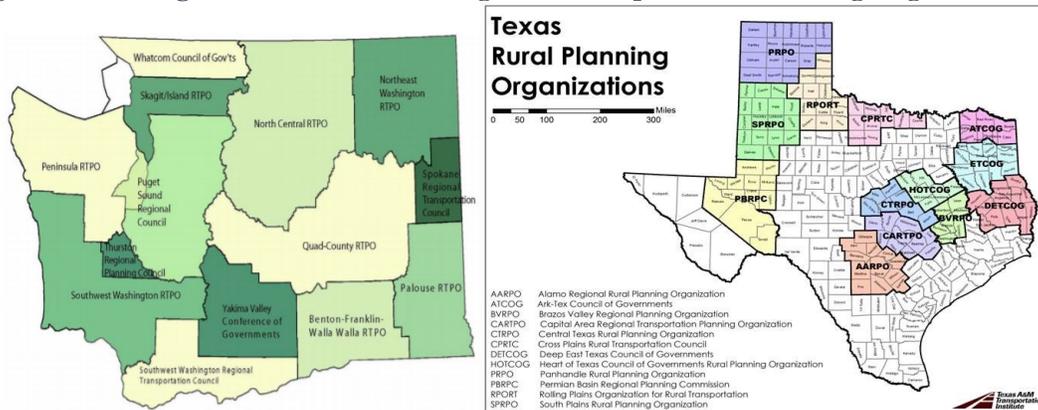
Transit Agencies

The main customers of electric buses are transit agencies that operate as Metropolitan Planning Organizations (MPOs) and Regional Transportation Planning Organizations (RTPOs). These government organizations are responsible for coordinating regional and government efforts in transportation planning, improvements, and policy. MPOs were created by the Federal-Aid Highway Act of 1962 to represent urban geographies with over 50,000 residents. MPOs are structured to contain a board that has transportation operators, state officials (where applicable), and locally elected officials while the MPO must also have advisory committees, and a director + staff.

MPOs are required to file a Long-Range Transportation Plan (LRTP) that “describes [the] vision for the region, and policies, operational strategies, and projects to achieve it” for the next twenty years, which must be refreshed every three to five years with public involvement.¹⁵ This is in conjunction with a shorter-term, biannual Transportation Improvement Program (TIP) that discusses the next year’s operational and management plan for all types of transit resources within a MPO’s territory, including roads, bus paths, rail, highways, bike paths, and more. The U.S. Department of Transportation (TOP) explicitly requires that TIPs include a financial plan and must strategize around expected and potential financial inflows and outflows. Many of these TIPs reveal plans and discussions that transit agencies are having regarding electric buses.

RTPOs, on the other hand, represent non-urban geographies (<50,000 people) to efficiently plan and design transit systems given close regional proximity. These rural agencies are created at the discretion of individual states if they deem RTPOs to be the most efficient way to coordinate rural areas; the alternative is for state-level transportation departments to take on this role. A single state can have many RTPOs. The state of Washington, for example, has 14 RTPOs, while the state of Texas has 13. Examples can be seen in Figure 6 below. Structurally speaking, RTPOs have similar organizational requirements as MPOs with a policy board, technical advisory committee, and planning staff and requirements to file LRTPs and TIPs. In this study, transit agencies refer to MPOs and RTPOs collectively.

Figure 6: Washington and Texas State Regional Transportation Planning Organizations^{16,17}



¹⁵ Department of Transportation (n.d.). “Metropolitan Transportation Planning: Executive Seminar”.

<https://www.planning.dot.gov/documents/metropolitanning/metrotrans.htm>

¹⁶ Washington State Department of Transportation (n.d.). “What is a Regional Transportation Planning Organization? (RTPO 101)”. <https://www.wsdot.wa.gov/partners/prtpo/docs/binder/rtpo101.pdf>

¹⁷ Rural Transportation (2016). “Texas”. <http://ruraltransportation.org/about-rtpos/rtpo-states/texas/>

Federal & State Agencies

The federal Department of Transportation is responsible for a varied range of transportation-related agencies under a budget of \$76.5 billion in fiscal year 2019.¹⁸ Its major agencies include but are not limited to the Federal Aviation Administration, the Federal Highway Administration (FHWA), and the Federal Transit Administration (FTA). The latter is of key importance as the FTA is responsible for programs that directly or indirectly provide assistance to municipalities and transit agencies looking to deploy electric buses, including but not limited to the Low or No-Emission Vehicle Program, Urbanized Area Formula Grants, and Formula Grants for Rural Areas. In addition, the Federal Highway Administration runs the Congestion Management and Air Quality Improvement Program (CMAQ), which targets emissions reductions through a variety of measures that includes electric vehicle infrastructure. Many of these programs were setup under the Fixing America's Surface Transportation Act ("FAST Act"), which was passed in December 2015 under the Obama administration and appropriated a total of \$305 billion across five years. \$48 billion of these funds were earmarked for transit projects specifically.¹⁹ These programs and their applicability to electric buses are further discussed in Section #3.

Another key agency is the California Air Resources Board (CARB) in conjunction with California Climate Investments (CCI). CARB is responsible for administering Assembly Bill 32, which passed in 2006 and mandates that the state reduces carbon dioxide emissions to 1990 levels by 2020 and 80% below 1990 levels by 2050. Started in 2013 in part to meet this legislation, California's Cap-and-Trade Program is a system of tradable carbon dioxide emissions permits, where initial permits are either allocated for free or auctioned to the highest bidder. Funds raised from this program (\$1.4 billion in fiscal year 2018) are used to fund additional carbon emissions reduction initiatives through the CARB's California Climate Investments vehicle, which include programs that benefit the adoption of electric transit buses like the Hybrid and Zero Emission Truck and Bus Voucher Project (HVIP) and the Transit & Intercity Rail Capital Program (TIRCP), amongst others.²⁰ These programs are also discussed further in Section #3.

Infrastructure Technology & Electric Utilities

Unlike the burgeoning growth of the light-duty segment for electric vehicles, heavy-duty electric vehicles have far less supporting charging infrastructure deployed nationwide. Charging locations can be typically classified into two types. The first is overnight, plug-in charging at centralized bus depots, where there is typically one charger per electric bus in the fleet (with a few potential backup chargers in case of equipment failure). These chargers tend to be lower capacity chargers at 50-200 kilowatts (kW) and are operated typically in a "trickle-charge" fashion to reduce overall load on the electric grid and strain on the bus batteries. Conversely, a single transit agency interviewed mentioned that they charge their buses at full power overnight to fill batteries in three hours as fast as possible to ensure bus availability.

The other type of charging is known as "opportunity charging", which typically consists of an on-route, high capacity charger (200-500 kW) that delivers short bursts of electricity to a bus over 2-10 minutes. This extends the range of buses by several to dozens of miles (depending on the charger capacity and duration of stop) for long-distance routes. These opportunity chargers are located at high traffic bus stops or terminals and typically use pantograph technology. Pantographs are overhead electrical connections made between an electric bus and a bus stop's electrical equipment. Inductive chargers, on the other hand, require no physical

¹⁸ Department of Transportation (2018). "Budget Highlights Fiscal Year 2019."

<https://www.transportation.gov/sites/dot.gov/files/docs/mission/budget/304476/508dotbh2019-b.pdf>

¹⁹ The Hill (2015). "Senate Sends \$305B Highway Bill to Obama". <https://thehill.com/policy/finance/262049-senate-sends-highway-bill-to-obama>

²⁰ California Climate Investments (2019). "2019 Annual Report: Cap-and-Trade Auction Proceeds". https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/2019_cci_annual_report.pdf

electricity connection (and therefore added operational convenience) but are more expensive and therefore rarer. Antelope Valley Transit Authority is one of the few transit agencies deploying inductive chargers.

Investor-owned utilities (IOUs) or municipal/public utilities are almost always involved with electric bus decisions for two reasons: charging infrastructure design and rate tariffs. The installation of either bus depot chargers or high-powered opportunity chargers generally necessitates that utilities get involved with upgrading infrastructure. The other important reason utilities become involved is due to discussions regarding electric rate tariffs. Progressive utilities, encouraged by public utilities commissions and state governments, are creating tariff schedules that incentivize the deployment of electric buses. For example, Southern California Edison (SCE), an investor-owned utility with 14 million customers in southern California, provides a “tariff holiday” to transit agencies deploying electric buses in parallel with its Charge Ready program. This waives expensive demand charges for five years under its new rate schedules, TOU-EV-8 and TOU-EV-9. Demand charges are monthly rates calculated based on the maximum power draw from the grid. As a comparison point, Proterra on-route chargers can use up to 500 kilowatts instantaneously. Under SCE’s previous Schedule TOU-EV-4 tariff, demand charges totaled \$15.51/kilowatt, which could cost a utility up to \$93,000 in demand charges alone (not including energy and fixed charges) in one year for that single opportunity charger.²¹

Financiers

To The only documented private financier to enter the electric bus financing space is Generate Capital. Generate Capital announced a \$200 million fund in July 2018 in partnership with BYD to finance electric bus leases. This partnership has led way to the development of new financing models for electric buses, revolving around several varieties of bus and battery leasing. These models are discussed further in Section #4.

Consultants

There are two notable non-profit centers focusing on electric bus deployment, given the sheer volume of clients and connections they have: CalStart, which is based in California, and the Center for Transportation and the Environment (CTE), which is based in Georgia. Both non-profit centers are commonly involved in the consulting, design, and evaluation of procuring electric buses for many transit agencies across the country. Both were interviewed in the course of developing this report and have informed many of the insights found in this paper.

Procurement Process

Transit agencies plan around replacing existing buses on a 12-year life cycle, based on the expected useful life of standard diesel buses as determined by Altoona tests. “Altoona testing” refers to Federal Transit Administration-required bus certification at the Bus Research and Testing Center, which is located in Altoona, Pennsylvania. In order for a new bus model to be eligible for federal fund assistance in the United States, bus models must pass a series of tests on “maintainability, reliability, safety, performance, structural integrity and durability, fuel/energy economy, noise, and emissions”.²²

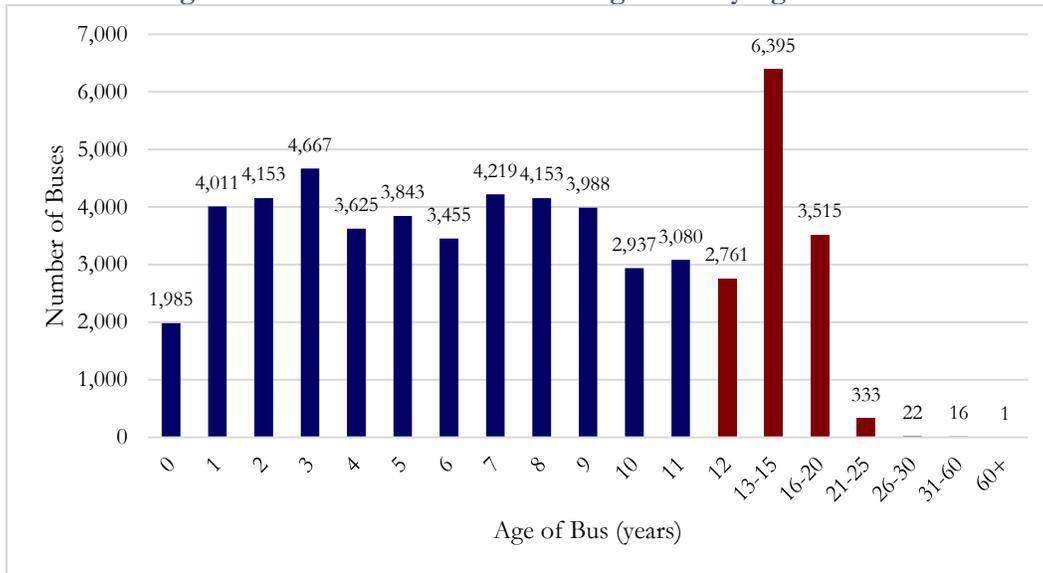
Most buses emerge from Altoona testing with a certified lifetime of 12 years. The 12-year lifetime designation from Altoona testing is significant because it determines the minimum operational lifetime of a bus before it becomes eligible for replacement with federal funds. Transit agencies commonly plan around 12-year lifetime cycles. Figure 7 shows the distribution of existing buses by age in years as of 2017, based on the National Transit Database (maintained by Federal Transit Administration). Thousands of buses hit the 12-year lifetime

²¹ Southern California Edison (2019). “Schedule TOU-EV-4 General Service Time-of-Use Electric Vehicle Charging – Demand Metered”. <https://www1.sce.com/NR/sc3/tm2/pdf/ce141-12.pdf>

²² LTI Bus Research and Testing Center (2019). “Bus Research and Testing Center”. <https://www.altoonabustest.psu.edu/>

each year, showing a much larger market potential for electric bus deployment than is currently seen in the market.

Figure 7: U.S. Distribution of Existing Buses by Age in 2017²³



From the point of the decision to replace a bus with an electric one, transit agencies must follow one of two routes. Option one is to partner with an electric bus manufacturer in a sole-source bid and apply for federal grants together – frequently Low-No grants. This option will be mostly phased out in fiscal year 2020 as the FTA has deemed the electric bus industry mature and competitive enough such that RFP processes will no longer be too cumbersome to conduct.

Option two is to conduct an open request for proposal (RFP) process that invites electric bus manufacturers to submit bids to fulfill a bus order. RFPs are open solicitation, competitive processes designed to obtain the lowest cost and best quality bids from multiple manufacturers that benefit the customer. The tradeoff is that RFPs can be time-intensive and complex to design, release, and evaluate. Consultants and independent evaluators are sometimes brought in to facilitate RFPs, which adds cost. Joint procurement via state-facilitated RFPs or regional pairings of transit agencies (discussed further in Section #6) is becoming more common and helps share the cost of holding RFPs amongst more parties.

²³ Federal Transit Administration (2018). “National Transit Database: 2017 Vehicles”. <https://www.transit.dot.gov/ntd/data-product/2017-vehicles-0>

Section #3: Current Funding Mechanisms

This section explores the upfront cash-based business model that is currently the norm in the electric bus industry due to federal grant, state grant, and Volkswagen emissions scandal settlement funds.

Federal Grant Money

FTA: Low or No-Emission Grant Program (5339(c))

The current federal vehicle for funding clean public transit infrastructure is the Low or No Emission Grant Program (“Low-No”), which was established in 2015 under the President Obama administration for the purpose of providing “funding for the purchase or lease of zero-emission and low-emission transit buses as well as for the acquisition, construction, or leasing of supporting facilities and equipment”.²⁴ The program number “5339(c)” refers to the subsection of the FAST Act that the program exists under (and are applicable for the next four FTA programs referenced as well). As of May 2018, the program had awarded \$110 million across the United States. An incremental \$84 million was awarded in the latest cycle between April and October 2018 while in January 2019, the FTA announced another \$85 million for fiscal year 2018.^{25,26}

Funding from the Low-No program is limited to 85% of the total cost of electric vehicles and 90% of the cost of supporting charging/fueling infrastructure. Applications are competitive and are reviewed based on six criteria: demonstration of need, demonstration of benefits, consistency with local planning priorities, local financial commitments, implementation strategy, and technical/legal/financial know-how. A key advantage of the Low-No program is the allowance for transit agencies to select a manufacturer to work and bid for funds with. This shortens the procurement timeline versus the more common and slower government funding model of developing an open, competitive request for proposal process. As mentioned in Section #2, this allowance will be phased out for fiscal year 2020 and the FTA cites added competitiveness and maturity in the zero-emission bus industry as its reason for doing so.

The application for Low-No grants is a simple first step for transit agencies and municipalities to receive initial funding for electric buses and supporting infrastructure. However, the program has several shortfalls as a primary source of capital. First, funding is highly competitive. The 2017 cycle of funding resulted in funding asks of \$515 million from 128 projects and only \$55 million of funding for 51 projects was awarded. With 11% and 40% success rates from the perspectives of total budget and total number of projects respectively, the Low-No funding program by no means a certainty. Fiscal year 2018 was even more competitive with 151 project applications requesting a total of \$558 million. Only \$84 million was awarded to 52 projects in 2018, with a success rate of 15% and 34% the perspectives of total budget and total number of projects respectively.

Second, funding amounts tend to be small, with a range of \$0.4 to \$2.3 million in the 2018 funding cycle with an average funding size of \$1.6 million. These funding amounts are likely only enough for 2-4 electric buses along with their associated infrastructure, which is typically much smaller than the average bus fleet. These grants are increasingly distributed across more and more states: in 2016, transit agencies in only 12 states received funding, while in 2017 and 2018, transit agencies in 34 and 41 states received funding respectively. Finally, Low-No funding and the Federal Transit Administration are subject to fluctuations in political

²⁴ Federal Transit Administration (2018). “Low or No Emission Grant Program Webinar”.

<https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/funding/grants/grant-programs/61121/low-no-nofo-webinar-2018.pdf>

²⁵ Federal Transit Administration (2018). “Fiscal Year 2018 Low or No-Emission (Low-No) Bus Program Projects”.

<https://www.transit.dot.gov/funding/grants/fiscal-year-2018-low-or-no-emission-low-no-bus-program-projects>

²⁶ Federal Transit Administration (2019). “FY 2019 Competitive Funding Opportunity: Low or No Emission Grant Program.”

<https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/funding/grants/grant-programs/131726/fy-2019-low-or-no-emission-competitive-grant-program-notice-funding-opportunity.pdf>

funding. This was highlighted by the partial federal government shutdown of in December 2018 and January 2019, where 493 of 558 total staff at the FTA were furloughed and no grants, contracts, or funds were provided during that time.²⁷

FTA: Bus and Bus Facilities Grant Program (5339)

The FTA's Grants for Bus and Bus Facilities Program, established under section 5339 of the FAST Act, is designed to help transit agencies "replace, rehabilitate and purchase buses and related equipment and to construct bus-related facilities including technological changes or innovations to modify low or no emission vehicles or facilities".²⁸ This is a competitive grant process that is not specific to zero-emission or electric vehicles, but does cover vehicle modifications. In 2018, \$366 million was awarded to bus and bus facilities improvement projects but only \$35 million went to projects specifically involving electric buses or electric bus infrastructure (slightly under 10% of total available funds). This program has similar match requirements to the Low-No program but with a minimum of 20% of project costs sourced from local funds.

FTA: Urbanized Area Formula Grants (5307, 5340)

The 5307 and 5340 programs contain funds that increase from about \$5.1 billion in fiscal year 2016 to \$5.5 billion in fiscal year 2020 on an annual basis.²⁹ Eligible recipients are public entities that serve urbanized areas with a population above 50,000 as determined by the U.S. Census. These funds can be used for anything from purchasing new buses to improving existing infrastructure but must be matched with a minimum 20% funds from local sources using a total project cost basis. This source of funding is the largest source of transit agency funding but is not specific to electric buses.

Funding is allocated towards transit agencies based on a combination of population, population density, and public transportation miles (which include rail, bus, and other modes of public transport). For urban areas with populations under 200,000, money is directly allocated to the governors of each state for distribution, while for urban areas with populations over 200,000, money is directly allocated to the transit agency of choice.

FTA: Formula Grants for Rural Areas (5311)

The 5311 Formula Grants for Rural Areas program is the natural complement to Urbanized Area Formula Grants. This program "provides capital, planning, and operating assistance to states and federally recognized Indian tribes to support public transportation in rural areas with populations less than 50,000, where many residents often rely on public transit to reach their destinations".³⁰ With funding of \$698 million in fiscal year 2016 escalating to \$759 million in fiscal year 2020, this program has a similar match requirement of a minimum of 20% local funds for capital projects. Roughly 83% of funds are allocated based on rural communities' land area and population, while the remainder of funds are allocated based on vehicle miles and low-income populations.

²⁷ Department of Transportation (2018). "Operations During a Lapse in Annual Appropriations – Plans by Operating Administration". <https://cms.dot.gov/sites/dot.gov/files/docs/mission/budget/328471/consolidated-december-2018-shutdown-plan-final.pdf>

²⁸ Federal Transit Administration (2016). "Grants for Buses and Bus Facilities Program". <https://www.transit.dot.gov/bus-program>

²⁹ Federal Transit Administration (2016). "Urbanized Area Formula Program Grants". https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/funding/grants/37961/fast-act-section-5307-fact-sheet_0.pdf

³⁰ Federal transit Administration (2016). "Fact Sheet: Formula Grants for Rural Areas". <https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/funding/grants/40621/5311-rural-program-fact-sheet-fast.pdf>

FTA: Capital Investments Grants (5309)

The FTA's 5309 Capital Investments Grants program invests in heavy infrastructure program that typically relates to fixed guideway projects. Fixed guideway refers to transit options that have priority right-of-way, such as light rail systems or transit bus systems with dedicated bus lanes and accelerated passage through traffic lights. The latter typically resembles bus rapid transit (BRT) routes, which frequently qualify as fixed guideways. The Capital Investments Grant program contains a large pool of funds with \$2.3 billion available annually from fiscal year 2016 through 2020 with no planned escalation at time of passing.³¹ However, these funds are again, not specific to but can be used for electric buses. For example, the Indianapolis Public Transportation Corporation (IndyGo) was awarded \$100 million from this program to deploy the Blue Line Rapid Transit route, which includes purchasing twenty new 60-foot electric buses to provide service between the airport and downtown Indianapolis.³²

FHWA: Congestion Mitigation and Air Quality Improvement Program

Historically, the Federal Highway Administration (FHWA), housed within the Department of Transportation, has run the Congestion Mitigation and Air Quality Improvement (CMAQ) program since the 1990s, when the Clean Air Act was originally passed. Funding for this program was re-authorized as part of the FAST Act in 2015, where \$2.3 billion was authorized in fiscal year 2016, rising to \$2.5 billion in fiscal year 2020.³³ This program focuses on helping states attain compliance with federal air quality standards established via the Clean Air Act (and updated over time), targeting pollutants and emissions like particular matter, carbon monoxide, and ozone.

These funds are allocated to individual states, who have many competing projects they could spend money on. These project types include “diesel retrofits and port related equipment and vehicles” as well as “public transit, bicycle and pedestrian facilities, travel demand management strategies, alternative fuel vehicles, facilities serving electric or natural gas-fueled vehicles”.³⁴

State Grant Money

The largest sources of state government funding for electric buses come from California, as discussed in Section #2. These include three major programs: (1) the Hybrid and Zero-Emission Truck and Bus Voucher Project; (2) the Low-Carbon Transit Operations Program, and; (3) the Transit & Intercity Rail Capital Program.

California: Hybrid and Zero Emission Truck and Bus Voucher Project

CARB runs the Hybrid and Zero-Emission Truck and Bus Voucher Project (HVIP) with assigned voucher amounts per electric bus. As of April 11th, 2019, there are 32 eligible electric transit buses across six different manufacturers with rebates between \$80,000 to \$315,000 per vehicle (with most buses receiving either \$120,000 or \$150,000, although these vouchers may be higher due to involvement with disadvantaged communities (DACs) that can enhance the value of the voucher).³⁵ To date, 399 vouchers have been awarded for zero emission vehicles worth approximately \$60.3 million as of the end of March 2019 (which includes

³¹ Federal Transit Administration (2016). “Fact Sheet: Fixed Guideway Capital Investment Grants”.

https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/5309_Capital_Investment_Grant_Fact_Sheet.pdf

³² Federal Transit Administration (2018). “IndyGo Blue Line Rapid Transit”.

<https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/funding/grant-programs/capital-investments/115311/indianapolis-blue-line-profile.pdf>

³³ Federal Highway Administration (2016). “Congestion Mitigation and Air Quality Improvement Program”.

<https://www.fhwa.dot.gov/fastact/factsheets/cmaqfs.cfm>

³⁴ Federal Highway Administration (2016). “A Summary of Highway Provisions”.

<https://www.fhwa.dot.gov/fastact/summary.cfm>

³⁵ California HVIP (2019). “HVIP Eligible Vehicle Catalog”. <https://www.californiahvip.org/eligible-technologies/#approved-vendor-list>

the first hydrogen fuel cell bus in March 2019). In addition, many vouchers have been awarded to industrial trucks, medium-duty commercial trucks, and school buses in addition to transit buses as well as some hydrogen fuel cell buses.³⁶

Voucher amounts are designed to help offset the incremental cost of a zero-emission bus versus natural gas buses. The voucher process is designed to be frictionless with HVIP approved manufacturers or dealers submitting voucher requests on behalf of fleets. HVIP vouchers can be used in conjunction with other grant funding.

California: Low-Carbon Transit Operations Program

The Low-Carbon Transit Operations Program (LCTOP) is a program administered by the California Department of Transportation (Caltrans) focusing on increasing transportation access for disadvantaged communities while reducing greenhouse gas emissions. Of the \$97 million awarded in fiscal year 2017-2018 from Caltrans, \$13.6 million was directed to 25 transit agencies for electric bus deployment. Altogether, these funds targeted 57 electric bus purchases (primarily to replace existing diesel or compressed natural gas buses) and 12 individual charging infrastructure projects to enable electric bus adoption.³⁷

California: Transit & Intercity Rail Capital Program

Administered by the California State Transportation Agency (CalSTA), the Transit & Intercity Rail Capital Program (TIRCP) focuses on a broad range of transit system improvements. Its latest round of funding in fiscal year 2018 provided \$2.65 billion of funds to spur a total of \$19.06 billion in total investment across 28 projects in California transit system improvements. Of these \$2.65 billion in funds, zero emission buses were the core focus of nine projects across Alameda Contra Costa Transit District, Anaheim Transportation Network, Antelope Valley Transit Authority/Long Beach Transit, the City of Fresno, the City of Los Angeles, the City of Santa Monica, San Francisco Municipal Transit Agency, Santa Barbara County Association of Governments, and the Shasta Regional Transportation Agency, meaning \$136 million in TIRCP funds anchored a total investment of \$308 million from all sources combined.³⁸

Other States

Texas ran a Clean Fleet Program from 2010 through 2018 with \$56 million in total funds provided to transit agencies, but all projects funded were compressed natural gas, liquefied petroleum gas, or diesel-electric in nature.³⁹ It appears that this may potentially change with the fiscal year 2019 applications, where the Capital Metropolitan Transit Authority in Austin applied for (but has not yet won) \$2.5 million in grants to fund \$9.3 million in electric buses.⁴⁰ Washington runs a Regional Mobility Grant Program with \$93 million in funds for 2017 through 2019, but with the majority of funds going towards transit services, park-and-ride lots, and other transit improvements and only a handful of funds going toward new electric buses.⁴¹

Large-scale pools of funding were not found while researching other states, outside of the Volkswagen emissions settlement funds.

³⁶ California HVIP (2019). "Deployed Vehicle Mapping Tool". <https://www.californiahvip.org/tools-results/>

³⁷ Caltrans (2018). "FY 17-18 LCTOP Project List". <http://www.dot.ca.gov/paffairs/pr/2018/docs/lctop-fy1718-public-awards.pdf>

³⁸ California State Transportation Agency (2018). "Transit and Intercity Rail Capital Program 2018 Awards". http://www.dot.ca.gov/drrmt/docs/sptircp/2018_awardlist.pdf

³⁹ Texas Commission on Environmental Quality (2018). "Texas Clean Fleet Program: Projects by Fuel Type". https://www.tceq.texas.gov/assets/public/implementation/air/project_summaries/TCFP_Fuel.pdf

⁴⁰ Texas Commission on Environmental Quality (2019). "Texas Clean Fleet Program: List of Applications Received Fiscal Year 2019".

https://www.tceq.texas.gov/assets/public/implementation/air/terp/tcf/FY19_TCFP_Appls_Recvd.pdf

⁴¹ Washington State Department of Transportation (n.d.). "Public Transportation – Regional Mobility Grant Program". <https://www.wsdot.wa.gov/transit/grants/mobility>

Volkswagen Emissions Settlement Funds

In 2015, Volkswagen was accused of intentionally deceiving transportation regulatory agencies in masking the true amount of various air pollutants (including nitrous oxides) using software controls embedded within “defeat devices”, which within the United States, were primarily designed to pass tests from the EPA and the California Air Resources Board (CARB). After lengthy lawsuits and investigations in 2016, federal judges approved a settlement offer of \$10 billion to be restituted to owners of Volkswagen vehicles (including Audi and Porsche brands) via vehicle repurchases. More importantly, Volkswagen was also required to spend an additional \$2.925 billion on nitrous oxide mitigation and \$2 billion on clean vehicle infrastructure. The \$2.925 billion was paid out to individual U.S. states based on the number of impacted Volkswagen vehicles. These funds were then distributed to local or municipal transit agencies for clean vehicle development or purchases.

Of the four states with transit agencies interviewed in this study, California, South Carolina, Texas, and Washington received \$423, \$34, \$209, and \$103 million respectively from the Volkswagen settlement from the \$2.925 billion in nitrous oxide mitigation funds.⁴² These funds are eligible for a wide range of activities, including “replacing or repowering older engines for newer engines at a rail switchyard, or could include replacing older city transit buses with new electric-powered transit city buses”.⁴³ Each state’s allocation of Volkswagen funds are described below.

- The state of California will distribute its \$423 million in total funds in the following fashion: \$130 million towards zero-emission transit/school/shuttle buses, \$90 million towards zero-emission Class 8 trucks, \$70 million towards zero-emission freight and marine projects, \$60 million towards combustion freight and marine projects, \$10 million on light-duty electric vehicle infrastructure, and \$63 million in reserve, which will also cover administrative costs.⁴⁴
- The state of South Carolina decided to spend its Volkswagen emissions settlement funds on three primary categories: between 80 to 100% on school/shuttle/transit buses, between 0 to 10% on light-duty electric vehicle charging equipment, between 0 to 10% on discretionary uses for other categories, and up to 1% on administrative expenses.⁴⁵
- The state of Texas will distribute its funds to metropolitan transit agencies for discretionary use within eligible activities based on their proportionate share of air pollution within Texas. These are primarily concentrated around the Dallas/Fort Worth, Houston, San Antonio, Austin, El Paso County, Bell County, and Beaumont-Port Arthur areas, which collectively will receive up to 81% of funds.⁴⁶ The remainder of the funds were used for light-duty electric vehicle charging infrastructure and administrative expenses.
- The state of Washington will distribute \$9.4 million for electric transit buses, \$12 million for electric school buses, and the remaining \$120 million towards a broad range of infrastructure initiatives

⁴² Center for Climate and Energy Solutions (2016). “Volkswagen Settlement Funding: What Cities Should Know”. <https://www.c2es.org/site/assets/uploads/2016/09/vw-settlement-funding-what-cities-should-know.pdf>.

⁴³ Environmental Protection Agency (n.d.). “Volkswagen Clean Air Act Civil Settlement”. <https://www.epa.gov/enforcement/volkswagen-clean-air-act-civil-settlement>

⁴⁴ California Air Resources Board (2018). “State of California Beneficiary Mitigation Plan”. https://ww2.arb.ca.gov/sites/default/files/2018-07/bmp_june2018.pdf

⁴⁵ South Carolina Department of Insurance (2018). “Beneficiary Mitigation Plan for the State of South Carolina Under the Volkswagen Environmental Mitigation Trust”. <https://doi.sc.gov/DocumentCenter/View/11323/Beneficiary-Mitigation-Plan>

⁴⁶ Texas Commission on Environmental Quality (2018). “Beneficiary Mitigation Plan for Texas”. https://www.tceq.texas.gov/assets/public/comm_exec/pubs/rg/rg-537.pdf

including marine vessels, locomotives, heavy-duty vehicles, public ports, EV infrastructure, and state fleets.⁴⁷

⁴⁷ State of Washington Department of Ecology (n.d.). “Volkswagen Enforcement Action”. <https://ecology.wa.gov/Air-Climate/Air-quality/Vehicle-emissions/Volkswagen-enforcement-action>

Municipal Transportation Taxes & Bond Offerings

Some transit agencies are able to generate funds via local sales tax or property tax measures with dedicated use cases of improving local public transit infrastructure. When available, these funds supplement revenue generated from bus fares and passes. These two types of funds (local taxes and fare revenue) are the two most common sources of local match funding for FTA grants, which commonly require either a minimum of 15% or 20% of total project costs to come from local, state, or non-federal sources. Another approach for larger, sophisticated agencies is to issue municipal bonds (assuming strong credit rating and history for the municipality) with future repayments. Used appropriately, these two tools (raising local taxes and issuing municipal debt) can be used in combination with federal grant money (and state grants, where applicable).

For example, Greensboro Transit Authority in North Carolina raised \$3.84 million in transportation bond funds due to increased property tax increase.⁴⁸ It was able to afford this multi-million bond offering due to its AAA credit rating with all three credit rating agencies at the time.⁴⁹ This enabled the city to purchase four Proterra buses alongside \$1.45 million in federal Low-No grants. In another example, Dallas Area Rapid Transit (DART) is funded by a one-cent sales tax in the Dallas metropolitan area, which encompasses 13 different cities and 700 square miles. DART expects to generate \$894 million in fiscal year 2019 from this sales tax revenue alone, while fare revenue is only expected to contribute \$127 million. Other key sources of expected funding are \$83 million from Urban Area Formula Grants and \$50 million from commercial paper issuance, which shows the financial sophistication of a large transit agency like DART.⁵⁰

⁴⁸ Mass Transit (2017). “Greensboro Orders First Four All-Electric Buses”.

<https://www.masstransitmag.com/home/press-release/12381034/city-of-greensboro-north-carolina-greensboro-orders-first-four-allelectric-buses>

⁴⁹ Greensboro North Carolina (2016). “2016 General Obligation Bond Authorizations”. <https://www.greensboro-nc.gov/home/showdocument?id=31047>

⁵⁰ Dallas Area Rapid Transit (2018). “FY 2019 Business Plan” <https://dart.org/ShareRoot/debtdocuments/FY19BusinessPlan.pdf?nocache=1>

Section #4: New Financing Mechanisms

This section discusses new financing mechanisms that extend beyond federal, state, and Volkswagen grant applications that can accelerate faster adoption of electric buses via disruptive business models.

Bus & Battery Leasing

In the relatively novel battery leasing financing mechanism, transit agencies purchase the electric bus or vehicle up front and explicitly exclude the battery pack. The battery pack is then leased (typically from the electric bus manufacturer) separately, where the transit agency makes monthly or annual payments for use of the battery. This lowers upfront capital expenses, with the target of achieving upfront cost parity with diesel buses. Alternatively, a whole electric bus can be leased (including the battery pack) with smaller or no upfront fees. Most of the current electric bus leases are 1-2 years in length for transit agencies to pilot-test the operation of the bus. Longer-term leasing, however, is also being explored as an option.

Discussions with numerous transit agencies indicate that the main obstacle to the leasing business model is the current reliance on federal grant funding. It is an easy decision for transit agencies to apply for matching funds from the FTA (and to a certain extent, state funding) and reduce the overall cost for a vehicle with no payments down the road versus paying nothing upfront but with many repayments in the future. For now, the leasing business model will remain uncommon with low volumes of buses being purchased and deployed that can be covered by current levels of grant funding. However, as transit agencies eventually scale up to replace entire fleets with electric buses, grant money may no longer be sufficient. Transit agencies like the New York Metropolitan Transit Authority are currently testing leasing models to both understand electric bus technology but also to test the business model for leasing prior to expected larger deployments.⁵¹ Bus and battery leasing will become a far more common business model in the future.

Two case studies are provided below. The first case study revolves around Park City Transit, the local transit agency serving its namesake ski resort in Utah, which financed six electric buses from Proterra by leasing just the batteries on the bus while purchasing the bus itself. The second case study focuses on Generate Capital and BYD's partnership to provide a larger variety of lease arrangements.

Case Study: Proterra and Park City Transit

In 2017, Park City Transit obtained FTA Low-No grants worth \$4.4 million (across two years) to deploy Proterra buses.^{52,53} In order to maximize the value of these funds, Park City Transit agreed to enter a battery lease agreement with Proterra, where Park City Transit would own the electric buses, charging infrastructure, depot, and storage sites. On the other hand, Proterra will own and service the batteries on the bus. A preliminary, unsigned battery lease agreement from November 2016 provided a number of key lease terms and covenants as detailed below (located on packet pages 168 to 202 within the Park City Council Meeting notes cited).⁵⁴ The initial bus purchase agreement established a maximum price of \$614,679 per bus (\$460,350 for the bus, \$147,054 for configuration options, and \$7,275 for spare parts), a maximum price of \$349,000 for each of two overhead charging stations, and a maximum price of \$40,000 for a depot charger. The lease terms below describe the batteries of the buses, which were leased separately. An important caveat: the purchase

⁵¹ New York Metropolitan Transit Authority (2018). "MTA Testing 10 New, All-Electric Buses to Reduce Emissions & Modernize Public Transit Fleet". <http://www.mta.info/news/2018/01/08/mta-testing-10-new-all-electric-buses-reduce-emissions-modernize-public-transit>

⁵² Federal Transit Administration (2017). "Fiscal Year 2016 Low or No-Emission (Low-No) Bus Program Projects". <https://www.transit.dot.gov/funding/grants/fiscal-year-2016-low-or-no-emission-low-no-bus-program-projects>

⁵³ Federal Transit Administration (2018). "Fiscal Year 2017 Low or No-Emission (Low-No) Bus Program Projects". <https://www.transit.dot.gov/funding/grants/fiscal-year-2017-low-or-no-emission-low-no-bus-program-projects>

⁵⁴ Park City Transit Department (2017). "City Council Staff Report: Proterra Battery Lease Agreement". <https://www.utah.gov/pmn/files/271549.pdf>

and lease deal terms cited may have changed in the final agreement between Proterra and Park City Transit, which was not disclosed.

- **Term length:** twelve years, with the option to sign a 12-year agreement or an initial duration of four years plus two renewal periods of four years each. The renewal of the contract is legally expected as long as Park City Transit is able to reasonably source funds to continue the lease arrangement.
- **Compensation:** the twelve-year lease cost would be \$2,961,000 upfront (equivalent to an annual rate of \$40,708/bus/year). The multi-period option would cost \$288,650 per bus with \$120,000 per bus for the first renewal term and \$80,000 per bus for the second renewal term. The total cost of this lease will be \$2,931,000 over twelve years for the six buses (equivalent to an annual rate of \$40,708/bus/year).
- **Limited operational guarantee:** Proterra guaranteed that its batteries would operate at above 70% of their original nameplate capacities. Proterra is responsible for maintenance of the batteries to ensure this level of performance and is allowed to replace or service its batteries at any point after coordination with the customer.
- **Mileage:** additional service fees of \$0.50/exceeded mile to be rendered to Proterra if bus mileage exceeds 90,260 miles in any given year.
- **Approved use conditions:** the bus batteries must be maintained between 20% and 90% state of charge at all times, with ten exceptions provided for falling to the 10-20% range across any five-year period. Additional charge/discharge amperage rates, temperature ranges, and voltages can be found in the preliminary lease agreement.

Case Study: Generate Capital and BYD

Generate Capital, founded in part by Jigar Shah (founder of SunEdison) as a specialty finance company focused on sustainable infrastructure assets, provided \$200 million in funds dedicated to BYD customers to deploy electric bus financing in partnership with BYD. Together, the two companies formed Green Transportation Leasing (GTL), which is a California LLC jointly owned by BYD and Generate. BYD's interest in this is to facilitate electric bus sales and BYD has said that they do not intend on making money on the financing of these leases (from BYD's end).

David Clamage is a leasing expert that Generate Capital has hired to help run GTL. From a phone conversation with Mr. Clamage (who generously provided his time for this interview), GTL offers two primary types of leases:

- **Tax-exempt leases:** also referred to as municipal leases, tax-exempt leases are leases made to government organizations where the lessor is not required to pay income tax on any interest earned via the lease. For electric buses as well as batteries and charging infrastructure individually or bundled, that means that GTL does not pay income tax on any interest earned on lease payments for BYD buses from a transit agency and can therefore charge a lower interest rate as a result. The transit agency (the lessee) makes lease payments out of its operational budget, typically owns the bus at the end of this arrangement, and is responsible for maintenance, insurance, and property tax expenses throughout the lifetime of the lease.⁵⁵ These lease rates are often structured at a small risk premium compared to municipal bond rates (which are around 4% on the high end and can often be quite a bit lower). However, this structure also is advantageous in that it does not require transit agencies to

⁵⁵ Association for Governmental Leasing and Finance (n.d.). "Frequently Asked Questions About Tax-Exempt Municipal Leasing". <https://www.aglf.org/faq>

go to voters for approval of these equipment purchases, which is the case in raising money via municipal bonds.

- **Residual leases:** for any customizable period of time, GTL has a residual value table that declines based upon a combination of BYD’s experience with the technology and the use profile of the customer over the length of the lease. For example, in year 1 of the lease, the BYD electric bus might be worth 70% of its value, while it might be worth 50% at year 2 (numbers are examples only, not GTL’s official values). GTL then funds the difference between the electric bus capital cost and the residual value. Commonly, these leases are 2-7 years, but GTL will structure deals up to 12 years. Buses and batteries can be funded as a bundle or individually in this model. The residual value lease works because Generate Capital and BYD are extremely confident in the residual value of their buses and can repurpose the batteries for standalone battery storage. No public deployments have occurred using this model so far as GTL has been working on refinancing existing electric bus company leases, but volume is expected to pick up soon.

Overall, GTL leases are typically priced between 3.5% to 8%, depending on whether they are structured as tax-exempt or residual leases. GTL also provides another model with bus and/or battery and charging infrastructure ownership as an energy service, where public transit agencies would pay GTL an all-inclusive \$/kWh rate based on how much energy they charge from the grid that covers the total cost of any financed costs including the electric bus, chargers, and electric infrastructure upgrades. This model is discussed in the “Energy as a Service” section below.

A summary of the advantages of and disadvantages of bus and battery leasing is provided below in Table 2.

Table 2: Bus/Battery Leasing Advantages & Disadvantages

#	Advantage/Disadvantage	Description
Advantages	Lower upfront expenses	By paying less (battery lease) or nothing upfront (bus lease) for an electric bus, leasing navigates the largest constraint that transit agencies face: limited capital budgets.
	Quick-access capital	Municipal leases can be expedited without going through lengthy voter approval processes on ballots.
	Monetization of residual value	The risk of higher-than-expected bus depreciation is transferred to bus manufacturers, who have stationary storage options for monetizing partially degraded batteries.
	Path towards battery replacement	Manufacturer takes ownership of batteries after negotiated period of time or after useful life.
Disadvantages	Financial & warranty complexity	Splits in ownership (e.g. battery leasing) and financial contract complexity adds credit risk and warranty negotiations; these discussions can be lengthy and intricate, particularly for smaller transit agencies without large staff familiar with finance.
	Higher cost of capital	Leasing is a more expensive financing option than municipal bond issuance (although the interest premium can vary from small to large), which can often be raised at an interest rate of 4% or less. ⁵⁶
	Grant funding >> leases	At the moment, there is no reason to lease when there is sufficient capital grant money to buy down the cost of an electric bus. This may change if grant funding becomes limited in the future and applies when transit agency customers wish to

⁵⁶ U.S. PIRG Education Fund (2018). “Paying for Electric Buses”. <https://uspig.org/sites/pirg/files/reports/National%20-%20Paying%20for%20Electric%20Buses.pdf>

		separate bus and battery/charging infrastructure from grant or other subsidized funding.
	Higher operational budget use	Lease payments become part of operational budgets, which may also face financial constraints.

Utility Investment & Ownership

One business model floated in the electric vehicle industry is to shift some or all of the charging infrastructure associated with electric buses to companies who specialize in electric infrastructure: in other words, to electric utilities. Investor-owned utilities have strong incentives to be involved in any type of electrical infrastructure – primarily because eligible capital investments can be placed into a highly-scrutinized “rate base” that the utility can earn a regulated rate of return on (typically between 9-11% in the United States). These costs plus the investment rate of return are recovered via electricity tariffs charged to electricity consumers. While this process is standard for traditional utility investments like transmission and distribution wires and metering infrastructure, utilities have also attempted to make inroads into rate-basing charging stations on the basis that electricity is effectively a utility’s end product. Portland General Electric is one utility that has successfully applied this model to electric bus infrastructure, as seen in the case study below.

Case Study: Portland General Electric and Tri-County Metropolitan Transportation District of Oregon

In March 2016, the state of Oregon passed Senate Bill 1547, which mandated that investor-owned utilities to “file applications ... for programs to accelerate transportation electrification”.⁵⁷ Around this time, Portland General Electric (PGE) was approached by TriMet (a public transit agency serving the Portland metro area) to help the transit agency deploy electric buses as TriMet had no interest in owning and operating charging infrastructure. At the same time, Tri-Met had applied for federal grant money to buy electric buses but wanted to PGE’s financial assistance with charging infrastructure so that TriMet could purchase five electric New Flyer buses instead of four. As a response, PGE put together a three-pronged proposal to TriMet to satisfy SB 1547 requirements:

1. Build, own, and operate six light-duty vehicle charging stations
2. Build, own, and operate TriMet’s bus depot charging infrastructure + an on-route charger
3. Invest in education outreach regarding transportation

This proposal required the approval of the Public Utilities Commission of Oregon, which was not without its own challenges. Several companies in the charging infrastructure space opposed the plan, citing uncompetitive monopoly behavior in the light duty charging space as a key concern. PGE was able to navigate this opposition successfully by agreeing on a hard limit on the number of stations that PGE could construct without further approval. Ultimately, the commission approved their plan and they are allowed to rate-base their investments at a 9.5% return on equity.

In this process, however, PGE was required to conduct standard utility benefit-cost tests that are typically used with utility energy efficiency programs, with the Ratepayer Impact Measure (RIM) test of particular importance. The RIM test is typically used to evaluate whether a program or activity will increase rates paid.⁵⁸

⁵⁷ Oregon Legislative Assembly (2016). Senate Bill 1547.

“<https://olis.leg.state.or.us/liz/2016R1/Downloads/MeasureDocument/SB1547/Enrolled>”

⁵⁸ Energy Trust of Oregon (2018). “Cost-Effectiveness Board Learning Paper”. https://www.energytrust.org/wp-content/uploads/2018/05/Board_Learning_Topic_Cost-Effectiveness.pdf

Overall, PGE’s infrastructure support includes building out new conduit and transformers needed to upgrade local distribution wires, five 100 kW bus chargers, and a 300 kW on-route rapid charger.⁵⁹

Another method for utility involvement in the electric bus space is through vehicle-to-grid (“V2G”) configurations. Aggregated at a depot, electric buses could charge or discharge their batteries from the grid when not in active transit use and when the utility or system operator needs it most (potentially based on locational marginal pricing or operator signals). This charge/discharge capability could be used to provide ancillary services like frequency regulation or spinning reserve backup power, while it could also be used to shift renewable energy production in wind- and solar-heavy states. While not covered in this report, the case for electric school buses is even stronger due to a larger number of non-usage hours after school activities conclude that coincide with evening grid power consumption as well as no bus operation during summer months. This model is being explored by Lion Electric with its partners Con Edison (the local utility) and the White Plains school district in New York.⁶⁰ Blue Bird Corporation, another electric school bus company, revealed that it was working on integrating V2G technology into its school buses at a 2017 conference.⁶¹

However, this business model does present challenges in terms of operating incentives. Transit agencies are incentivized to maximize the useful life of the bus and its associated batteries, which is inversely correlated with the number of cycles a battery is put through. Using the bus battery for any services outside of regular transit service will degrade the battery faster, which misaligns grid operator incentives with the transit agency’s incentives.

A summary of the advantages and disadvantages of utility involvement in the electric bus charging space is provided below in Table 3.

Table 3: Utility Investment Advantages & Disadvantages

#	Advantage/Disadvantage	Description
Advantages	Maximizes utility expertise	Operating and installing charging infrastructure aligns with utility expertise, which can speed up the design and construction process.
	Generates additional revenue (V2G)	Additional revenue from grid services adds to operational budget, which can be used for other reasons such as leasing additional electric buses.
	Lowers system costs	Placing infrastructure costs on the utility lowers the overall upfront cost to transit agencies, who can purchase more electric buses instead of chargers or wiring upgrades.
	Larger pools of capital	Utilities have historically been viewed as safe, stable investments, meaning they could use their balance sheets to inject capital designed for infrastructure investments at high credit ratings.
Disadvantage	Misaligned operation	Use of the bus battery for anything except regular transit service is not in the transit agency’s best interest in prolonging the life of the battery and as a result, its range in miles.

⁵⁹ Portland General Electric (2017). “Transportation Electrification Plan”. <https://www.portlandgeneral.com/-/media/public/residential/electric-vehicles-charging-stations/documents/pge-ev-plan.pdf?la=en>

⁶⁰ Con Edison (2018). “Electricity from School Bus Batteries Will Support Con Edison Grid Reliability”. <https://www.coned.com/en/about-con-edison/media/news/20180619/electricity-from-school-bus-batteries-will-support-con-edison-grid-reliability>

⁶¹ Blue Bird Corporation (2017). “Blue Bird Introduces All-New Electric School Bus Solutions”. <https://www.bluebird.com/about-us/press-releases/134-blue-bird-introduces-all-new-electric-school-bus-solutions>

Opposition on monopoly grounds	Non-utility charging infrastructure competitors strongly oppose utility ownership of charging infrastructure on the grounds that doing so grants monopoly power and reduces competition.
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Energy/Transportation-as-a-Service

While no current energy/transportation-as-a-service business models are currently deployed at public transit agencies, there are a number of companies developing these models, which range from \$/mile, \$/kWh, and on-bill tariffs (regarding utility bills) as a revenue models. The core of these energy-as-a-service models is to shift the administrative burden from non-energy organizations/companies to companies that can provide an integrated, simple package. Three examples are shown below:

- **AMPLY Power**, a Mountain View, CA-based startup with venture capital funding, provides fleet “Charging-as-a-Service” for light duty, delivery, industrial, and municipal transit fleets. Per the company’s website, Amply Power will fund infrastructure deployment and installation costs while optimally charging an electric vehicle fleet.⁶² The revenue model exists on a dollar per mile driven case, which aligns AMPLY’s guarantee of 90% state of charge availability every 24 hours with a transit agency’s incentives and encourages AMPLY to minimize both electric fuel and maintenance expenses.
- **Generate Capital and BYD’s** partnership is also selling energy, transportation, charging, or batteries to transit agencies deploying electric buses, where GTL would invest in the charging infrastructure and electrical system upgrades and charge a fee for electricity consumed from the grid to recover this investment. This initial investment could include the electric buses (which would correspondingly increase the electricity margin).
- **Clean Energy Works**, a non-profit organization based in Washington D.C. focusing on renewable energy, has developed a “Pay As You Save” (PAYS) system for financing cleaner transportation options.⁶³ This model operates similar to how energy efficiency contracts are developed in that electric utilities cover some or all of the capital expenditure for electric buses and owns the battery and charging infrastructure. The transit agency customer then pays a “fixed charge on monthly electric bills that is less than estimated savings versus diesel” back to the utility. Interestingly, cost recovery will depend on the threat of utility disconnection as versus creditor claims.⁶⁴ A graphical representation of these relationships can be seen in Figure 8.

⁶² AMPLY Power (2019). “Simplifying Fleet Electrification”. <https://www.amplypower.com/actexpo2019interview/>

⁶³ Clean Energy Works (2018). “Tariffed On Bill Finance to Accelerate Clean Transit.” <http://www.cleanenergyworks.org/clean-transit/>

⁶⁴ Climate Finance Lab (2018). “Pay As You Save for Clean Transport”. <https://www.climatefinancelab.org/project/pay-save-clean-transport/>

Figure 8: Clean Energy Works' Pay-As-You-Save (PAYS) Model⁶⁵

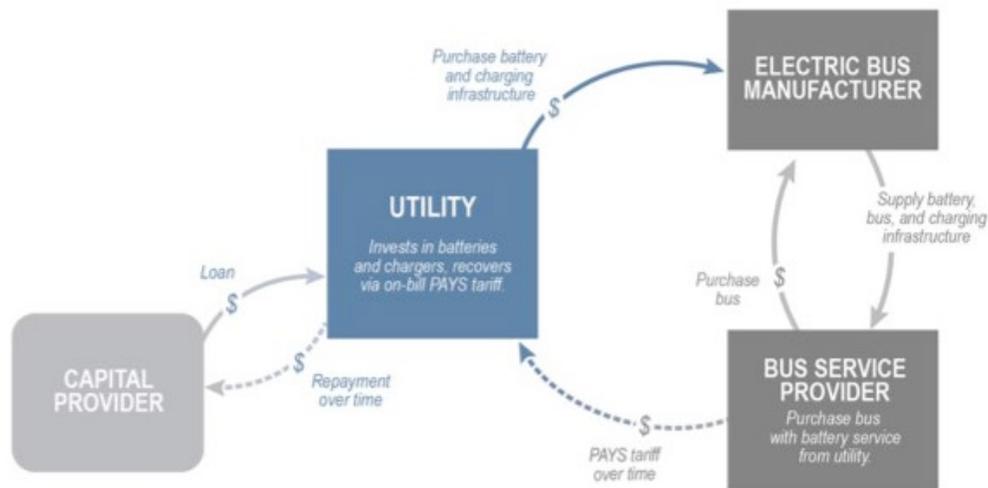


Table 4 below summarizes the advantages and disadvantages of energy-as-a-service models for transit agencies adopting electric buses.

Table 4: Energy-as-a-Service Investment Advantages & Disadvantages

#	Advantage/Disadvantage	Description
Advantages	Simplifies work	Allows transit agencies to focus on transit services rather than optimizing fleet charging, maintaining electrical equipment, and managing utility bills.
	Spreads cost premium over bus lifetime	Aligns electric bus cost premium with fuel and maintenance savings over the lifetime of the bus.
Disadvantages	Contractual complexity	Contracts will likely have many clauses and covenants governing warranties, technical operating parameters, maintenance, and other factors that will need to be ironed out.
	Electric tariff uncertainty	Long-term fixed payments expose energy service companies to tariff risk and change every few years during utility rate cases.
	Unproven models	While having deployments in the energy efficiency space, these models are unproven with regards to charging infrastructure.

⁶⁵ Clean Energy Works (2018). "PAYS® for Clean Transport – Q&A". <http://www.cleanenergyworks.org/qa-pays-for-clean-transport/>

Section #5: Selected Case Studies

This section showcases four example deployments of electric buses – one from each state covered in this report – based on interviews with transit agencies and highlights key information on costs, funding sources, infrastructure, and bus deployment processes.

California | City of Porterville | Richard Tree

The City of Porterville began exploring electric buses at the same time in 2014 as Antelope Valley Transit Authority (a nearby, early-adopting southern California transit authority), according to Rich Tree, the Transit Manager for the City of Porterville. Historically, Porterville has had poor air quality and electric buses were seen as one avenue for pollution reduction. Although the city’s initial conversations were with Proterra, Porterville began working with GreenPower Bus, a relatively new upstart in the electric bus space, once they indicated interest in siting a local manufacturing facility. Once completed, Porterville’s charging infrastructure will consist of ten overnight chargers at the bus depot and one opportunity charger at a central transit center. However, Porterville’s master plan (which was sent to Southern California Edison) will have a total build of 40 bus chargers. One conditional requirement of the CARB grant received (discussed later in this section) is to prioritize renewable energy components where possible, so Porterville will build a bus canopy with solar panels. It is unclear whether this solar system will feed the bus chargers directly.

Southern California Edison (SCE) is providing a rebate of \$200,000 to partially mitigate the cost of installing chargers. In addition to this, SCE is providing a demand charge fee waiver for the first five years of operation. Rich’s team considered implementing demand-side solutions to mitigate demand chargers but ultimately decided against pursuing additional infrastructure costs.

Table 5: City of Porterville Electric Bus System Summary*

Equipment	Quantity	Unit Cost	Total Cost
GreenPower Bus	10	\$891,568	\$8,915,680
BTCPower Charging Stations	11	\$58,585	\$585,849
Southern California Edison Charger Rebate	--	--	\$200,000
Total			\$9,701,529

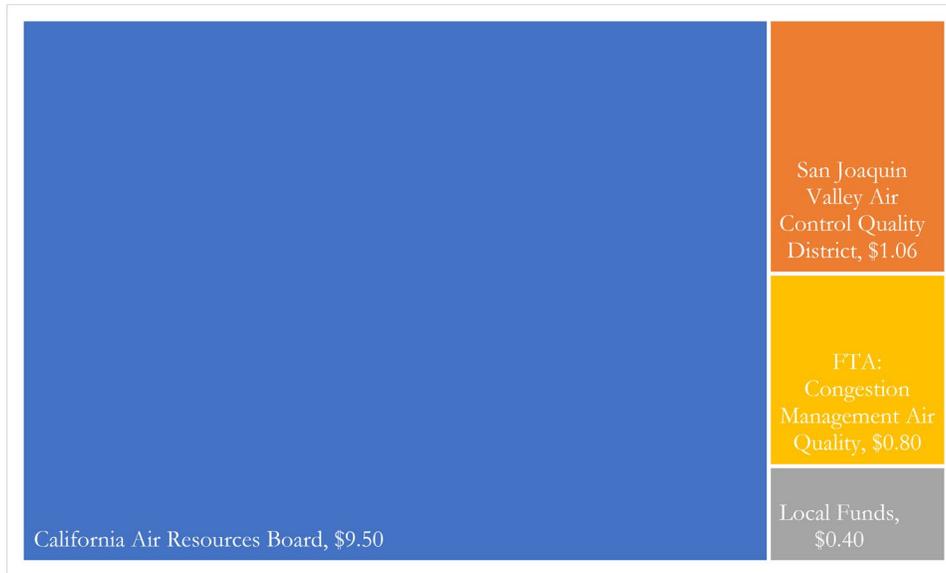
**Estimated budget by report author based on interview with the City of Porterville and secondary budget research; these numbers may not be a fully accurate representation of actual spend.*

From a long-term perspective, Mr. Tree was unique amongst transit agency managers in that he was looking at business cases for second-life batteries (for when those on his GreenPower buses degraded enough) and is closely following lithium-ion technology trends. This may provide a revenue source at the tail-end of the expected twelve-year lifetimes of these batteries. In soliciting funding for electric buses, Mr. Tree’s three-person staff worked with GreenPower to write grant proposals and was able to obtain three external grants – a \$9.5 million grant from the California Air Resources Board and two grants from the San Joaquin Valley Air Pollution Control District with \$459,270 earmarked for buses and another \$600,000 for electric bus infrastructure. They were not selected in bidding for the FTA’s Low-no program but used another \$400,000 from local transportation funds (i.e. city budget) and another \$800,000 from FHWA Congestion Management Air Quality funds that were already in hand.

Mr. Tree did not look at any other financing models like battery leasing but is aware of the model and is open to it in the future. He considered taking a loan to advance the project, which became more sharply in focus with the federal government shutdown in December 2018 – January 2019 (causing delays in federal funding payments). An opportunity presented itself when Lancaster passed a sales tax increase, but increased funds

were earmarked for street improvement and medical first responder purposes as opposed to transit buses. A summary of funding sources can be seen in Figure 9 below.

Figure 9: City of Porterville Funding Sources for Electric Bus Deployment (\$ millions)



South Carolina | City of Greenville/Greenlink | Nicole McAden

The City of Greenville contractually operates Greenlink, the branded name for the Greenville Transit Authority, under significantly different circumstances than the California agencies. Based in South Carolina, Greenlink operates a relatively smaller transit system with sixteen 35-foot diesel buses, of which four are past their useful life of twelve years, having been bought in 2002. As the Marketing & Public Affairs Manager, Nicole McAden was gracious enough to discuss Greenlink’s current fleet, process of purchasing electric buses, infrastructure, and funding. Greenlink’s decision to replace diesel buses with four electric buses is born out of necessity as the operational costs of maintaining these older diesel buses are becoming untenable. Greenlink needed new buses, regardless of technology type. Of no less importance, however, is the presence of Proterra’s manufacturing facility in Greenville itself, lending itself to an easy working relationship. Greenlink’s purchase decision had strong support from its board of directors as well as politically via federal, state, and local government (including Senator Lindsay Graham) and did not run into any major opposition.

As it stands, Greenlink has an existing order with Proterra for four, 40-foot Catalyst E2 buses. Nicole McAden mentioned that Greenlink needed to wait for a model of the Catalyst bus with extended range as previous models could not accommodate the ~213-mile daily routes that Greenlink runs. Two of the buses were delivered to Greenlink on April 11, 2019. The final two buses are expected to be delivered before May 31, 2019. Four overnight chargers (maximum discharge rate unknown) will be installed in Greenlink’s existing maintenance facility.

Table 6: City of Greenville/Greenlink Electric Bus System Summary*

Equipment	Quantity	Unit Cost	Total Cost
Proterra Catalyst E2 Bus	4	\$851,807 – \$871,757	\$3,447,128
Spare Parts	--	--	\$59,703
Bus Chargers	4	\$42,500	\$170,000
Electric Power Construction	4	\$23,206 – \$30,000	\$3,783,243
Total	--	--	\$3,785,653

**Estimated budget by report author based on interview with Greenlink and secondary budget research; these numbers may not be a fully accurate representation of actual spend.*

This project was funded under a FTA Low-No grant of \$1.45 million awarded in fiscal year 2017 with \$244,024 of matching funds from the South Carolina Department of Health and Environmental Control and \$12,000 in local business commitments. It is notable that local businesses pitched in money (however small of a percentage) as it shows that they value the benefits of local electrified public transit. Greenlink was able to also leverage \$164,106 of funds from FTA 5339(a) Urban Area Formula Grant funding as well for this project, which counted as local match funding (for a total match of 22.47%, satisfying the 80/20 guideline for Low-No). These values can be seen in Figure 10 below.

Figure 10: Greenlink Funding Sources for Electric Bus Deployment



For Greenlink, the FTA funds were critical for bus replacement as their operational budget shortfall prevented any large capital expenditures, particularly with only about \$1 million in fare revenue per year (that would also be used for other transit agency operations). In addition, state level revenue support is minimal for public transit, as the State Mass Transit Fund (SMTF) only receives \$0.0025/gallon of gas sold in South Carolina (a state-level gas sales tax) and the SMTF is then split between 27 transportation providers across the state. Greenlink’s FY2019 SMTF appropriation was \$434,000. According to Ms. McAden, Duke Energy – as Greenlink’s regional electricity supplier – is aware of and involved with the upcoming deployment of Proterra buses and is requesting an allotment of funds from the South Carolina Public Service Commission to deploy both light-duty and heavy-duty electric vehicle charging infrastructure.

Texas | Dallas Area Rapid Transit | Beverly Adler

Dallas Area Rapid Transit (DART) is another example of a transit agency willing to push the envelope on new technologies, which is exemplified by their venture into electric buses. Beverly Adler, who is an Assistant Treasurer in charge of DART’s grant applications amongst other financial responsibilities, was kind enough to provide her insights regarding DART over the phone in March 2019.

Titled the Zero Emission Electric Bus (ZEEB) project, the total funds used in 2018 were \$10.1 million, with \$7.6 million of those funds coming from the FTA’s Low-No program in 2015.⁶⁶ The remaining \$2.5 million

⁶⁶ Dallas Area Rapid Transit (2017). “FY 2018 Business Plan”.

was obtained from a 1% dedicated regional sales tax that specifically funds the transit agency from its 13 local member cities.

Seven Proterra 35-foot electric buses were purchased and deployed on a route named D-Link, which is a high-profile, high-traffic downtown Dallas route. These buses were deployed in July 2018 and will be charged at the Dallas Convention Center, where two quick overhead chargers costing \$810,000 were installed. The planned D-Link route is only 19 miles, while a ten-minute charge at the Convention Center stations will replenish 30 miles of range. The cost of each bus was \$971,000.⁶⁷

On future plans, DART does plan on applying for Low-No funding in 2019 to deploy further electric buses. More information and future plans may be released when DART updates its long-range Transit System Plan in 2019, which specifically mentions capital expansion plans and potential adaptation of emerging technologies.⁶⁸ Independent research (outside of the interview) using data from the 2017 National Transit Database indicates that DART's fleet is relatively young, with 586 of its 601 bus fleet aged six years or younger by the end of 2017 and only 15 buses needing replacement (between 13-15 years old). For this reason, it seems unlikely that DART will purchase more electric buses for replacement reasons but may continue purchasing if developing new route service.

Washington | Everett Transit | Melinda Adams

Located north of Seattle in Snohomish County, Everett Transit operates a fleet of 42 buses that service close to two million passengers per year. As a Program Manager for Everett Transit, Melinda Adams was gracious in lending her time in conducting a phone interview discussing her agency's electric bus transition. Back in 2014 and 2015, Everett Transit began looking at electric buses in the context of transitioning to cleaner vehicles leveraging renewable energy sources. Initially, the agency worked with the University of Texas to study route simulations and determine what kind of charging infrastructure would be required.

The majority of Everett Transit's fleet is past or approaching the 12-year FTA-defined useful lifetime, with 17 buses over 15 years of age and an additional 13 buses within two years of the 12-year milestone as of June 2018. To replace many of these buses, Everett Transit obtained three separate grants from federal and state sources. The first grant was through the 2016 Low-No program, with \$3.36 million awarded in fiscal year 2016 to purchase four electric buses. Another grant worth \$1.38 million came from the 2017 Bus and Bus Facilities Grant Program (5339 funds), which will provide for two electric buses and their associated charging infrastructure. More funds were sourced from the Regional Mobility Grant Program funds of \$2.88 million were awarded for three electric buses. This aligns Everett Transit's near-term plan to deploy nine electric buses between 2018 and 2020 with Proterra as its main manufacturing vendor.⁶⁹ Fortunately for Everett Transit, it is partially funded by a 0.6% local sales tax. Everett Transit also expects to apply for Volkswagen emissions settlement funds from Washington state.

These grants are accompanied by an initial charging infrastructure design consisting of four bus depot chargers and another charger at Everett Transit's maintenance facilities, each of which will cost \$39,000. All-in costs for electric buses are \$1.1 million, inclusive of charging infrastructure. Everett Transit considered bus leasing but ultimately opted to leverage only grant money as leasing would have created more administrative

⁶⁷ Dallas News (2018). "Electric Buses Are Coming to DART's Downtown D-Link by the End of March". <https://www.dallasnews.com/news/transportation/2018/01/18/electric-buses-coming-darts-downtown-d-link-end-march>

⁶⁸ Dallas Area Rapid Transit (2019). "DART Transit System Plan". <https://www.dart.org/about/expansion/transitsystemplan.asp>

⁶⁹ Everett Transit (2018). "Transit Development Plan 2018-2023". <http://everetttransit.org/DocumentCenter/View/1138/Everett-Transit-Transit-Development-Plan-TDP-2018---2023?bidId=>

burden in involving other city officials. Longer-term, Everett Transit also won an \$8.5 million CMAQ grant that will be used to deploy nine electric buses by 2022. A summary of funding sources can be seen below in

Figure 11: Everett Transit Funding Sources for Electric Bus Deployment



California | Antelope Valley Transit Authority

Antelope Valley Transit Authority is provided as a final case study given that it has deployed electric buses at a larger scale and more advanced stage than nearly any other transit agency in the United States. An interview conducted with Mark Perry, Director of Operations & Maintenance at AVTA for the previous nine years, was highly enlightening. AVTA serves the southern California cities of Palmdale and Lancaster as well as parts of Los Angeles County. In a 2014 board meeting, the City of Lancaster expressed a desire to be as green and self-sufficient as possible and the board directed AVTA to explore fleet electrification. After further research, discussions with manufacturers, and an order of two pilot buses from BYD, the AVTA board publicly announced its intention in 2015 to go 100% electric by 2018. In addition, as a pro-business municipality in southern California, Lancaster has traditionally tried to spur commercial investment, which was one of the primary reasons that BYD setup a manufacturing facility there.

A few short months after that, AVTA successfully applied for Transit and Intercity Rail Capital Program (TIRCP) grants from California (program covered in more detail in Section #3) worth \$24.4 million. This enabled it to award BYD with a \$79 million contract for up to 85 electric buses in January 2016. Through 2016 and 2017, AVTA continued to win additional funding with another \$6.8 million from TIRCP and \$0.7 million from Low-No. AVTA also used portions of its 5307 Urban Area Formula Grant funding to fund electric bus deployments (program discussed further in Section #3) totaling \$8.9, \$9.1, \$9.6, and \$9.5 million in 2015, 2016, 2017, and 2018 respectively.^{70,71,72,73} All of these were matched with \$8.4 million in local AVTA funds as of 2017 (although more local funds have likely been used since then).⁷⁴

AVTA's charging infrastructure ranks amongst the most complex deployed in the United States to date. With 85 electric buses expected in their fleet, AVTA has a central bus charging depot located in next to its headquarters in Lancaster, California with 89 plug-in, conductive chargers that can charge at a rate of 80 kW or 200 kW. At the depot, buses are charged at full power to ensure that buses are available in case of an emergency or a charger malfunctioning.

AVTA also solicited wireless, inductive chargers via RFP and worked with SCE to participate in its Charge Ready program and obtain a demand charge tariff holiday. These inductive, wireless chargers (one 50 kW charger, three 250 kW chargers) were installed for two reasons: (1) daily bus mileage on some routes require opportunity charging to extend bus range and (2) the cities of Lancaster and Palm Dale have ordinances restricting overhead construction (i.e. limited opportunities to build new power lines). An added benefit is that two new planned inductive chargers will be located close to a medical center and non-profit food & clothing donation center, enabling better low-income community access.

The last part of AVTA's charging infrastructure includes a 1.5 MW backup diesel generator in case of grid emergency. Perry indicated that this generator is not used on a regular basis for any electric bill mitigation. AVTA's headquarters has on-site solar carports on a separate meter that is designed to make the headquarters

⁷⁰ Antelope Valley Transit Authority (2014). "Fiscal Year 2015 Business Plan".

<https://www.avta.com/downloads/792.pdf>

⁷¹ Antelope Valley Transit Authority (2015). "Fiscal Year 2016 Business Plan".

<https://www.avta.com/downloads/1324.pdf>

⁷² Antelope Valley Transit Authority (2016). "Fiscal Year 2017 Business Plan".

<https://www.avta.com/downloads/1620.pdf>

⁷³ Antelope Valley Transit Authority (2017). "Fiscal Year 2018 Business Plan".

<https://www.avta.com/downloads/1618.pdf>

⁷⁴ BusCon (2017). "Antelope Valley Transit Authority".

<https://eventsimages.bobitstudios.com/upload/pdfs/bcs/2017/speaker-presentations/a-look-at-conductive-inductive-charging-of-electric-buses-len-engel-91217-945am.pdf>

self-sufficient and does not interface with the charging stations. As of January 2019, AVTA's fleet consists of 43 electric buses, which is approximately half of its existing fleet.

Section #6: Analysis, Market Forecast, and Takeaways

This section provides a summary of current electric bus adoption drivers/barriers and key takeaways for the future of the industry while providing suggestions for further research that could be done in the electric transit bus space. These are informed by the many primary interviews conducted and extensive secondary literature research.

Key Drivers and Barriers of Adoption

Table 7 summarizes the top drivers of and barriers to electric bus adoption in the United States.

Table 7: Drivers of and Barriers to Electric Bus Adoption

#	Drivers & Barriers	Description
1	Bus replacement funding	Federal funding for all types of buses stipulates that buses can be replaced after their useful lifetimes of 12 years; substantial grant funds are available.
2	Simplified financials	Transit agencies make decisions based on allocated capital and operational budgets versus investment metrics like NPV and IRR, which simplifies and streamlines the decision process.
3	Health & environmental	Electric buses reduce smog emissions, noise pollution, and consume less overall energy than diesel.
4	Technology leadership	Some transit agencies strive to be at the vanguard of technology adoption. In California, this has translated to a 100% zero-emissions fleet requirement by 2040.
1	Lack of state level funding	FTA local match requirements (~20% for Low-No, ~50% for urban area formula funding) necessitate non-federal money matches. Many transit agencies outside of California struggle to break even on bus fare revenue alone.
2	Space & charging constraints	Existing depots & facilities are not designed for electric buses and must be repurposed; alternatively, new ones must be built from scratch. Existing utility electrical infrastructure may not be able to handle large increases in electric load.
3	Technology uncertainty	Range anxiety is a real concern, while performance warranties are key sticking points on negotiations. General technology unfamiliarity also contributes to initial reluctance to adopt electric bus technology.
4	Slow ramp for manufacturers	Buy America requirements (65% of cost) and high customization for U.S. transit agencies means slowed the ramp up rate of production capacity for bus manufacturers.

Takeaways

For the domestic electric bus industry to accelerate in the United States, five objectives need to be achieved in the industry: manufacturing ramp-up, aggregated purchase models, larger deal sizes, technology improvement, and policy development.

1. Manufacturing Ramp-Up

As mentioned in the introduction, there is likely still room for bus manufacturers to partner with municipalities to establish manufacturing bases. This would be similar to how Proterra, BYD, and Greenpower Bus have done with Greenville (South Carolina), Lancaster (California), and Porterville (California) respectively. However, while production rate data is not publicly available from major electric bus

manufacturers, it is clear that production capacity is still a major bottleneck for bus deployment with hundreds of buses on back order and lead times frequently extending beyond a calendar year.

Part of this constraint is dealing with high degrees of customization requested from customers, which slows down assembly rates. The other part is adapting to Build America requirements, which state that 65% of the cost basis of a bus needs to be sourced from domestic manufacturing. This can be a challenge given that lithium-ion production primarily occurs overseas that a battery pack can make up 26% of the cost of an electric bus. This is compounded by the lack of a developed supply chain for the low-volume electric market in the USA. However, manufacturers have navigated this issue by assembling battery packs in the United States, which treats lithium-ion cells as “sub-subcomponents that are substantially transformed into packs with modules, coolants, and sensors”.⁷⁵ This does in turn, present substantial policy risk as the industry anticipates the FTA making modifications to Build America requirements in 2019.

Both of these obstacles are challenges that potential new manufacturers from the Chinese market (such as Yutong, Nanjing Jinlong, Zhuhai Yinlong, and Futian Ouhui) should be aware of the difficulty of building customized buses, particularly if setting up domestic manufacturing bases. These are lessons that can be learned from BYD’s initial experience adapting from the volume-driven, mass production in the Chinese market. This includes managing Altoona testing timelines, which are well-documented and do not typically constrain electric bus development. However, manufacturers need to be prepared for schedules between 9-12 months and potential setbacks arising from these tests.

2. Aggregated Purchase Model

Electric bus manufacturers will be further incentivized to ramp up production capacity if transit agencies are able to group purchases together to create larger order quantities. Federal rules allow for joint procurement, which is defined as “a method of contracting in which two or more purchasers agree from the outset to use a single solicitation document and enter into a single contract with a vendor”.⁷⁶ Joint procurements typically occur between smaller, regionally-close transit agencies. This has two effects: (1) it reduces administrative costs by rolling multiple lengthy and costly RFP processes into one and (2) it can drive volume price discounts from bus manufacturers. As rural and smaller transit agencies evaluate shifting their fleets to electric buses, they should strongly consider entering joint procurement agreements to most efficiently utilize existing funds and resources.

Note that these joint procurements must adhere to FTA requirements, one of which includes proof of reasonable need of the buses requested from each transit agency participating in the procurement. The point of this clause is to prevent the creation of excess bus purchasing options. The FTA is trying to avoid the practice of monetizing these excess options via option assignment – colloquially known as “piggybacking” – where the options are sold to other transit agencies that did not originally participate in the RFP. Transit agencies should closely study the rules of joint procurement when embarking on this option.

As it stands, there is movement toward state-level procurement contracts, where states can coordinate amongst many transit agencies to offer a streamlined, standardized purchase options via a large, statewide purchase option agreement. California is actively moving in this direction with a RFP released for nine different battery electric bus configurations (30-, 35-, 40-, 45-, and 60-foot buses along with low and high floored buses) with a standard price per bus (hydrogen fuel cell buses are also considered in this

⁷⁵ Congressional Research Service (2018). “Buy America and the Electric Bus Market”.

<https://fas.org/sgp/crs/misc/IF10941.pdf>

⁷⁶ Federal Transit Administration (2016). “Joint Procurements: Frequently Asked Questions”.

<https://www.transit.dot.gov/funding/procurement/third-party-procurement/joint-procurements>

solicitation).⁷⁷ This RFP provides relevant insights into current industry expectations through technical and contractual requirements, which include:

- Only new and current models are allowed, which removes refurbished buses from consideration.
- Buses being bid into this open procurement must comply with all FTA requirements, including Altoona test certification and Buy America requirements.
- Minimum operating range of 200 miles without recharging
- Complete bus warranty of two years or 100,000 miles (whichever comes first), with longer required warranties for specific bus components
- Battery storage warranty of six years or 250,000 miles for no more than 20% degradation of original capacity

At the time of publication, bids for this RFP are due in early May 2019 and decisions will be released in early June 2019. California’s quantitative evaluation criteria falls under two criteria: administrative/technical and cost. Notably, this California RFP awards bus manufacturers with 50 points (5% of total value) if they offer a battery leasing program. In addition, manufacturers offering extended battery storage warranties of three years and 125,000 miles receive 25 points, while a six-year, 250,000-mile warranty receives the full 50 points. These criteria can be seen below in Table 8 below.

Table 8: California Zero Emission Transit Buses Solicitation Evaluation Criteria

Scoring Category	Points
Administrative & Technical	
Customer References	150
Environmentally Preferable Purchasing	50
Employment Plan	50
Battery Leasing Program	50
Energy Storage Extended Warranty	50
Cost	
Cost Score	550
Mark-Up % (on factory custom options)	100
Total Points	1,000

3. Larger Deal Sizes

Deal size (in dollars) is important give the amount of due diligence and documentation required in any kind of financing, where banks and lending institutions gain economies of scale from larger deals. In other words, a \$100 million loan takes much less than 50 times the effort of a \$2 million loan. With most bus deployments occurring in the single digit to tens of millions of dollars range, there is likely reluctance from financial institutions to get involved, given alternative investments available in larger public-private partnerships in bridge, airport, and larger-scale transportation infrastructure. This is another nascent industry problem that is expected to change in the future as bus procurements become larger, as technology matures, and investors begin understanding the business model better.

4. Technology Improvements

As with all emerging and new technologies, there are growing pains with transitioning. The contentious relationship between the City of Albuquerque and BYD has been well-documented in the media. The

⁷⁷ State of California Department of General Services – Procurement Division (2019). “Request for Proposal: Zero-Emission Transit Buses.” <https://caleprocure.ca.gov/pages/Events-BS3/event-details.aspx>

municipality cited subpar range performance, battery overheating (with New Mexico reaching extremely hot temperatures), and bus safety concerns as reasons for terminating its initial bus purchase arrangement through ABQ Ride, its local transit agency.⁷⁸ Other potential causes for lower battery performance were (1) the abnormally high elevation on the bus rapid transit route that these buses were deployed on with over a thousand feet in elevation gain and (2) the lack of opportunity/rapid chargers along the lengthy route itself. On the flip side, political factors may have also influenced the outcome of this deployment and these issues continue to play out in legal courts. Battery performance issues are not unique to this singular deployment or geography; Proterra also experienced difficulties with operating batteries for the Minnesota Valley Transportation Authority (MVRTA), which services the Minneapolis region. When temperatures dropped below freezing points, range performance deteriorated dramatically.⁷⁹ However, it should be noted that these two examples are two of the only issues that have played out in the public eye and that both electric bus manufacturers have deployed numerous other buses without issues.

These growing pains are typical for a fledging new industry with new technologies, particularly one as complex as automotive batteries. In addition to temperature and range performance concerns, the industry and its customers is still wrapping its head around battery degradation and the residual value of batteries (a market gap that Generate Capital and BYD are trying to address through GTL). Some of these problems will be solved naturally over time as more years of data are collected – particularly degradation data from early adopters like Foothill Transit (2010) and Antelope Valley Transit Authority (2014). Other problems like range performance expectations are actively being addressed through better customer communication at the point of sale, but can continue to be improved. Once technology performance and longevity issues are addressed, third-party investor confidence is likely to be boosted, giving way to more funds flowing into what is currently an uncertain technology and product. This in turn, lowers the risk premium associated with deploying electric buses.

5. Policy Development

On a federal level, the FAST Act has certainly helped facilitate electric bus adoption through key grant and incentive programs like Low-No and the Bus and Bus Facilities Grant programs. However, recent legislation attempting to build on the FAST Act has stalled and is restricting industry acceleration. The Community Health and Clean Transit Act (S. 3720, by Oregon Senator Jeff Markle), failed to pass the Senate Committee on Commerce, Science, and Transportation in December 2018, which would have enabled zero-interest financing for electric buses on a national scale.⁸⁰ This bill would have appropriated \$15 million annually for zero-interest loans.

At the state level, there is room for support from states outside of California to develop grant programs that can initially jumpstart development in the electric bus space once Volkswagen settlement funds have run out. On the utility front, utilities need to initiate conversations with state regulators to step into the heavy-duty charging infrastructure business, similar to light duty vehicle infrastructure. This process will take several years of educational initiatives and demonstration that utilities are best suited towards operating this type of infrastructure while combating arguments that utilities are monopolizing charging infrastructure.

⁷⁸ Albuquerque Journal (2018). “Mayor Pulls Plug on Electric Bus Deal”. <https://www.abqjournal.com/1246094/abq-rejecting-all-byd-art-buses-switching-to-non-electric.html>

⁷⁹ CityLab (2019). “The Verdict’s Still Out on Battery-Electric Buses”. <https://www.citylab.com/transportation/2019/01/electric-bus-battery-recharge-new-flyer-byd-proterra-beb/577954/>

⁸⁰ U.S. Congress (2018). “S.3720 – Community Health and Transit Act of 2018”. <https://www.congress.gov/bill/115th-congress/senate-bill/3720/text>

Future Areas of Exploration

The Department of Transportation's Transportation Infrastructure Finance and Innovation Program (TIFIA) is a program that was not covered in this report. The TIFIA program focuses on lending money to \$100 million+ projects like highway systems and transportation terminals at a 3.04% interest rate (as of February 2019).⁸¹ This program could potentially be used for electric bus purchase orders that rise above 100 buses alongside the associated infrastructure development costs.

Electric school buses were originally included in the scope of this research project but were ultimately not covered due to significantly different business models, market players, and incentives. However, based on discussions with Lion Electric and individual market research, electric school buses are more stringently regulated and are fully dependent on government funding with minimal fare revenue. Conversely, electric school buses have a lower price tag than diesel buses, have higher potential volume of sales due to standardization, and have more room for the provision of electric grid services.

Another key area unaddressed in this report is the space in between light-duty electric vehicles (like Tesla Model 3s, Chevrolet Bolts, etc.) and large, public transit buses. This space includes companies like Chanje (medium-duty electric delivery vans), GreenPower Bus (the aforementioned EVStar commuter van), Phoenix Motorcars (the ZEUS electric shuttle bus), and Zenith (electric passenger, cargo, and step vans). These medium-sized vehicles could operate for municipal transit agencies but also have a role to play in private fleets serving corporations, delivery services, and more.

Along these lines, industrial electric vehicles have different value propositions and business models. Companies like Orange EV (T-Series), Daimler (eCascadia), Cummins (Aeos), Tesla (Semi), Volvo (VNR Electric), Lion Electric (Lion8), and Toyota (Beta) are developing Class 7/8 heavy duty electric trucks that can be used for in-terminal transportation, long-haul freight, and a variety of other options.

⁸¹ U.S. Department of Transportation (2019). "Transportation Infrastructure Finance and Innovation Act (TIFIA)". <https://www.transportation.gov/buildamerica/programs-services/tifia>

Appendix

SECTIONS: interview questions, Low-No awards, CalStart deployments table, potentially all sources

Appendix A: Interview Questions

Transit Agency Interview Questions

Qualitative Questions:

- Customer Discussion
 - How large is your current bus fleet? What are your plans for future electric bus purchases?
 - How did you approach the decision of whether to purchase an electric bus?
 - Were there any third-party analysts involved (consulting firms, independent evaluators, etc.)?
- Infrastructure
 - What kind of infrastructure have you developed to support your electric bus?
 - Can you go into any kind of details on how that was designed and how much individual components cost?
 - How are your utility bills handled?
 - Do you have any special tariffs with the utility? Did this go into the decision-making process?
 - Did you consider any demand-side management solutions to mitigate demand charges?
 - Can you send over any utility bills that you might have?
- Financing:
 - How did you finance the bus? Capital budget (straight cash), leasing program, municipal bonds, grants, etc.?
 - Did you look at any novel new financing mechanisms such as co-utility investment, battery leasing,
 - How do you evaluate the purchase of an electric bus?
 - Do you go through transit planning cycles and do you have a set capital budget for buses? Were you able to obtain additional funding for EV-specific buses?
 - What does the approval process look like with the local government?
 - What would you say were your biggest obstacles towards funding these bus purchases?
 - Have you evaluated any third-party financing?
- Close-Out:
 - Is there any cost documentation that you might be able to send over?
 - Do you have any other recommendations for people, companies, or types of organizations that I should speak to regarding this issue?
 - Can I contact you with further questions down the road?

Manufacturer Interview Questions

- Customer Discussion:
 - What is the level of technical knowledge that your customers typically have?
 - How do you approach cost discussions with the customer?
- Infrastructure:
 - Can you describe what existing partnerships you have with charging infrastructure providers?
 - Who provides charging equipment?
 - Who do you work with on developing bus depots?

- How much interaction do you have with local utilities? What kind of requirements do they impose?
 - What other major partnerships should I be aware of?
- Financing:
 - From your discussions with customers, what are their most common forms of financing the purchases of your electric buses?
 - Cash purchase, battery lease, bus lease, external investor
 - How does your company typically interact with these financiers?
 - Have you evaluated any third-party financing?
 - If so, can you describe any arrangements that you currently have?
 - What do these third-party financiers typically look for?
 - What are the most common challenges that customers face when lining up financing?
 - If you are comfortable sharing, what kind of IRRs does your company look for when it comes to deals?
- Close-Out:
 - Is there any cost documentation that you might be able to send over?
 - Do you have any other recommendations for people, companies, or types of organizations that I should speak to regarding this issue?
 - Can I contact you with further questions down the road?

Appendix B: State-by-State Zero-Emission Bus Deployment and Orders⁸²

Full State	State	Battery Electric Buses	Fuel Cell Buses	Total Zero Emission Buses	Transit Properties
Alaska	AK	1	0	1	1
Alabama	AL	1	1	2	2
Arkansas	AR	0	0	0	0
Arizona	AZ	0	0	0	0
California	CA	825	52	877	46
Colorado	CO	44	0	44	2
Connecticut	CT	6	0	6	1
District of Columbia	DC	14	0	14	1
Delaware	DE	16	0	16	1
Florida	FL	70	0	70	7
Georgia	GA	21	0	21	2
Hawaii	HI	5	0	5	1
Iowa	IA	3	0	3	1
Idaho	ID	2	0	2	1
Illinois	IL	59	2	61	7
Indiana	IN	66	0	66	2
Kansas	KS	0	0	0	0
Kentucky	KY	21	0	21	2
Louisiana	LA	9	0	9	3
Massachusetts	MA	15	1	16	4
Maryland	MD	16	0	16	4
Maine	ME	0	0	0	0
Michigan	MI	0	1	1	1
Minnesota	MN	12	0	12	2
Missouri	MO	11	0	11	2
Mississippi	MS	0	0	0	0
Montana	MT	4	0	4	2
North Carolina	NC	13	0	13	3
North Dakota	ND	0	0	0	0
Nebraska	NE	2	0	2	1
New Hampshire	NH	0	0	0	0
New Jersey	NJ	7	0	7	2
New Mexico	NM	18	0	18	2
Nevada	NV	5	0	5	2
New York	NY	29	0	29	5
Ohio	OH	3	10	13	1

⁸² CalStart (2018). "A Survey of Zero Emission Buses Across North America." <https://calstart.org/wp-content/uploads/2018/11/Breathing-Easy-August-2018.pdf>

Oklahoma	OK	2	0	2	1
Oregon	OR	12	0	12	3
Pennsylvania	PA	27	0	27	2
Rhode Island	RI	0	0	0	0
South Carolina	SC	22	0	22	3
South Dakota	SD	0	0	0	0
Tennessee	TN	19	0	19	2
Texas	TX	24	0	24	5
Utah	UT	19	0	19	2
Virginia	VA	1	0	1	1
Vermont	VT	2	0	2	1
Washington	WA	154	0	154	7
Wisconsin	WI	3	0	3	1
West Virginia	WV	0	0	0	0
Wyoming	WY	0	0	0	0